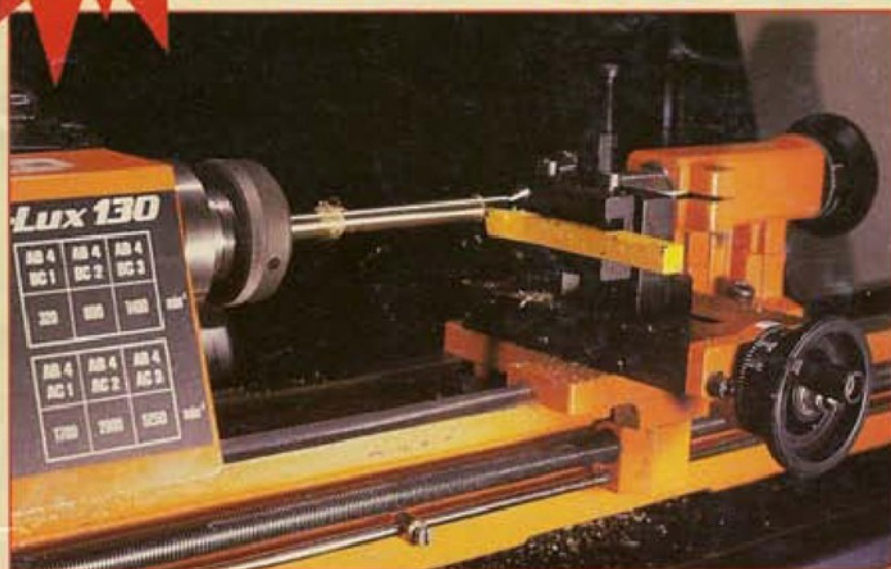


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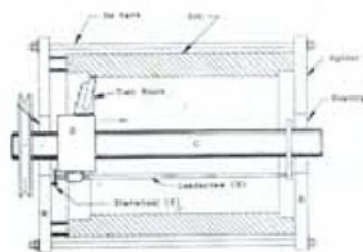
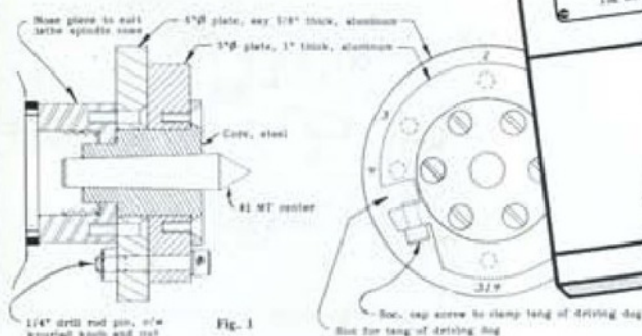
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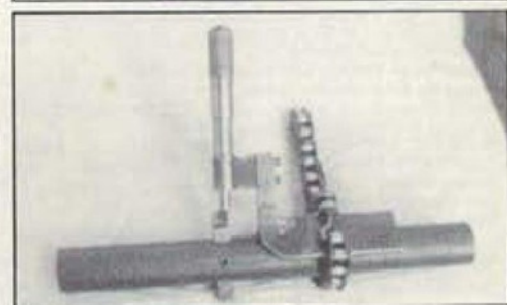
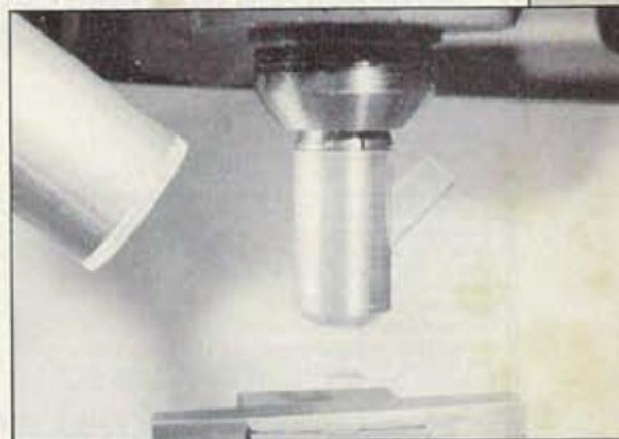
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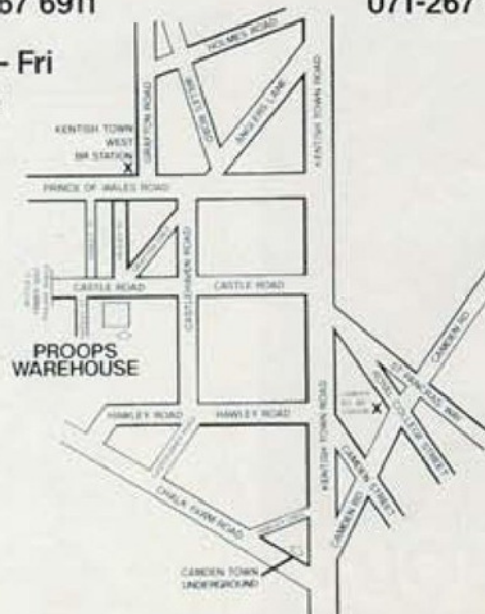
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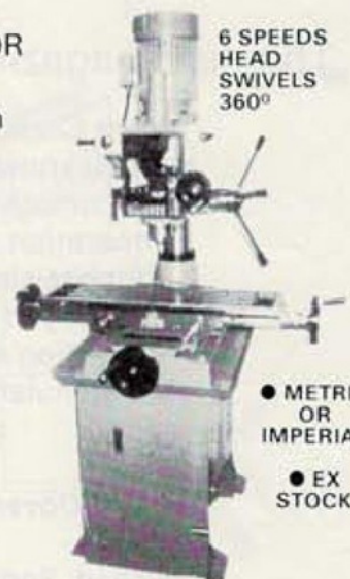


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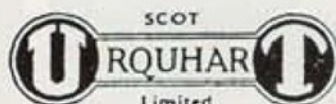
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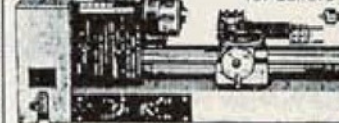
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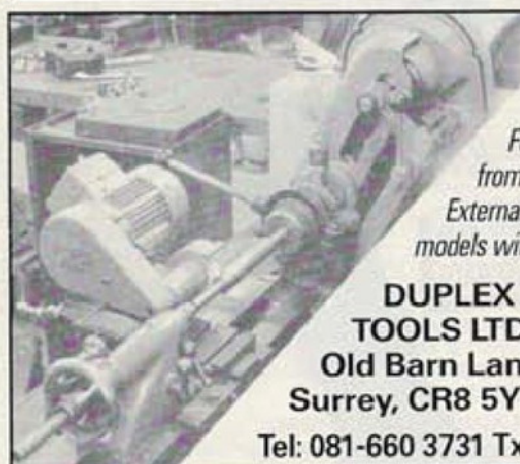


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HELLO, AND WELCOME!



Practising what he preaches; editor Stan Bray in the workshop at ASP's 1990 Primrose Valley Modelmakers' Holiday Week.

Welcome to *Model Engineers' Workshop*, a brand new magazine specially compiled for all those who are interested in using model engineering machinery at home to make models, tools and a host of other items!

Our subtitle is 'The new, practical hobby magazine' and that's exactly what we are with the accent very firmly on making things rather than merely reading about them. As you will see as you enjoy this first issue, the magazine is packed with practical articles describing the construction of a wide variety of useful tools and machinery improvement ideas ranging from the simple to the more complex. And this is a policy we intend to follow with future issues.

Although, as stated, the magazine exists to concentrate primarily on workshops and their use, it will also contain extensive information on the making of models and it is our intention to cover in depth the multiplicity of techniques involved in their construction. So whether you use your workshop solely for the purpose of creating magnificent live steam locomotives, traction engines and other working models, or obtain your enjoyment and satisfaction from the hobby through the manufacture of tools and workshop aids, there will always be something in *Model Engineers' Workshop* just for you.

In this first issue we have attempted to offer readers as wide a range of subjects to make as possible; we hope that we have got the balance about right but, naturally, we would love to hear what you have to say and will certainly act on any request that we receive. At the moment we are busy setting up a team of brand new writers who will come fresh with a new outlook and new ideas, whilst at the same time dealing with the traditional subjects.

All hobbies go through changes as materials and techniques improve and model engineering is no exception. Not very many years ago most model aircraft were built entirely from balsa and tissue with a little bit of spruce thrown in. Now many use expanded polystyrene, ABS plastics and modern composites, all glued together with one of the very latest cyanoacrylate 'super' glues. In model boating, too, the traditional wooden hull has largely given way, in the interest of speed and convenience, to plastic and glass fibre. Happily, in both cases, traditional building methods and materials are still used as well.

Model engineering is like this too. New exciting materials that can be invaluable in the home workshop are coming onto the market continually and *Model Engineers' Workshop*, while firmly basing itself on the traditional foundations of model engineering and home workshop practice, will also embrace these.

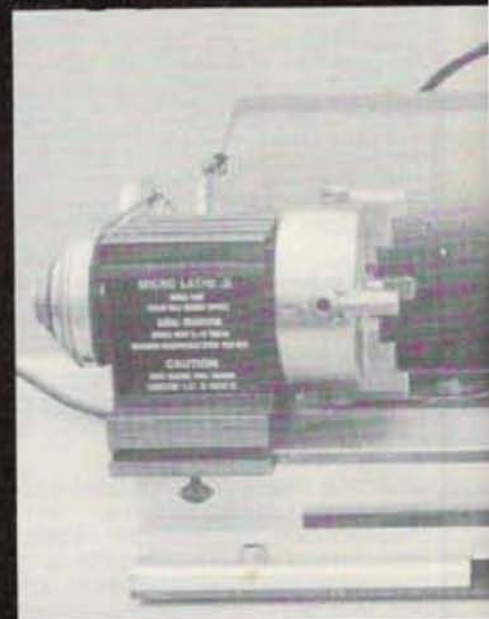
One of the biggest areas of change in engineering in general is the increasingly large part played by electronics with even the smallest of engineering works now having electronically controlled equipment. This does not mean that, even if they could afford it, all model makers will want to connect their machine to a drawing, put in the metal and wait for the finished article to appear at the end - there would not be a great deal of fun to be had in that, the best part, no doubt, being the book we were reading whilst waiting for it to happen!

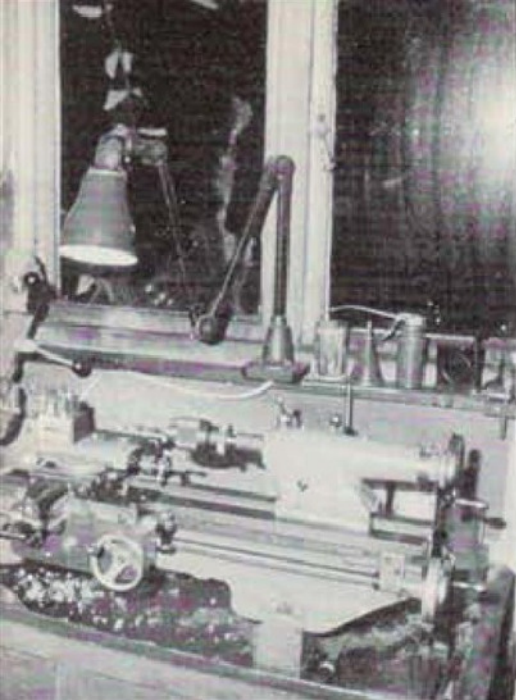
Nevertheless, limited electronic control can be very useful in the home workshop and make it possible to be much more

One of the nice things about the hobby is that a workshop can be created in many an odd corner; this one is at the end of a garage.

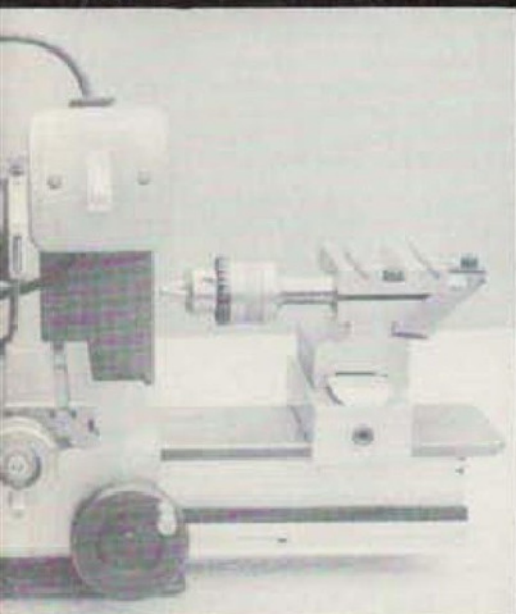


What it's all about! An evening in the home workshop means pleasure and relaxation.





And owners of miniature lathes such as this Peatol will also be catered for in MEW.



accurate with what we create. Where they're applicable to the home enthusiast, we will take all these new developments on board over the issues ahead just as enthusiastically as we will continue to concentrate on the traditional model engineering techniques.

I hope that this gives some indication of the way we intend *Model Engineers' Workshop* to go; like all of ASP's hobby magazines, MEW will represent a forum for readers' designs, ideas and techniques and therefore will rely heavily on readers telling us what they're making and how it is being made. We will be delighted to hear from anyone who has something to offer that will be of interest to others and it can range from a small idea like a quick tip right up to a major project like the super rotary milling attachment feature in this first issue. So let us know what you are up to; ideally, your copy should be typed with double spacing and, obviously, photographs and drawings where applicable should be included. We'll trace all of the drawings to MEW style in our drawing office so don't worry too much if your original drawings are in pencil or you are not the world's neatest draughtsman. What's more, we will pay you for your

efforts and, while you won't be able to make plans for immediate retirement to the south of France on what you earn, at least it will go a large part of the way towards the materials for that new project!

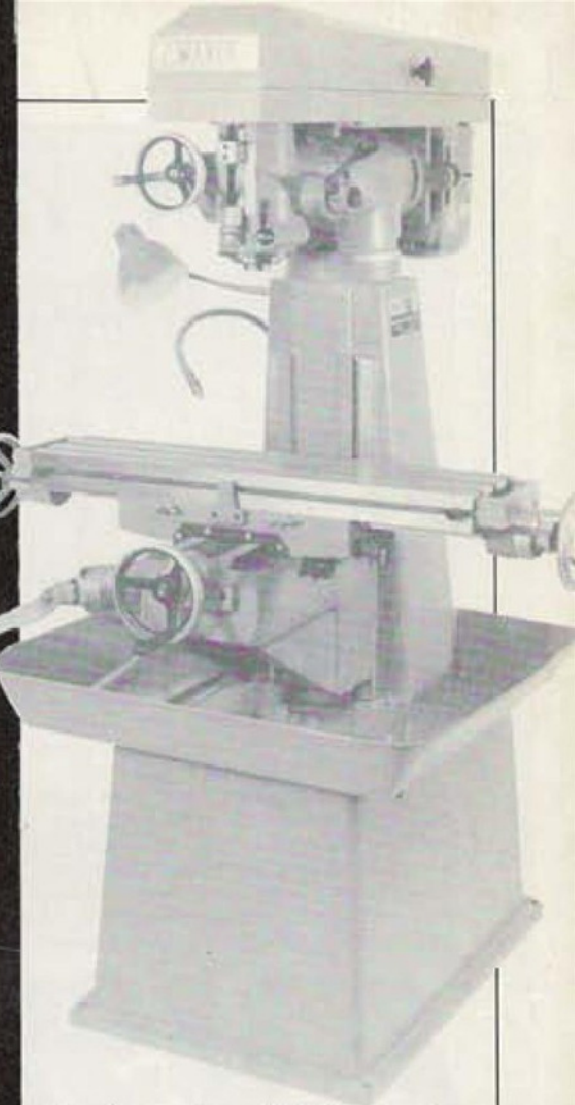
It is our intention in *Model Engineers' Workshop* to maintain the very highest standards and we are sure that readers will let us know pretty quickly if they feel that we are beginning to slip. As you can see from this first issue, we will be catering for both the advanced and the not so advanced and there will be material too for the absolute beginner since it is only through the encouragement of newcomers to our hobby that its future can be assured. The task represents something of a balancing act to cater for all levels of expertise and, as I said, I am sure you will let me know if you think we are beginning to stray from the straight and narrow! *Model Engineers' Workshop* is your magazine and I'll endeavour to make it just the way you want it.

Unlike its fortnightly parent, *Model Engineer*, MEW will not be embarking on the publication of long, multi-part series of articles. Instead, we intend to deal with each project on a one-off, start-to-finish basis in each issue, so you won't have to wait for the next instalment to complete a job. MEW is a workshop magazine and, as such, we will be featuring individual set-ups in each issue - you may even invite us to come and look at yours! What we will be looking for particularly is workshops which have something special about them; it might be a special design of storage, an unusual layout or you may have made a series of useful tools and workshop aids which you would like to share with other readers. Please let us know.

Here then is the first issue of *Model Engineers' Workshop*. As you can see, we offer several worthwhile items for your pleasure in constructing and use around your own workshop and we feel that there is something here for model engineers of all levels of ability. None of the items we discuss this time call for any particular castings so they can all be made with stock materials much of which will, no doubt, be found to hand in many workshops. The constructional features are spiced with some general interest articles, the occasional tip, your technical enquiries and some answers and a free pull-out working drawing which will be a common feature of each issue.

In preparation for the next issue is an equally mouth-watering line-up of material. For a start, there will be details of how to develop a low-voltage lighting system for the home workshop. Mains lighting can be dangerous and the system we offer next time is completely safe yet is capable of supplying good light to exactly the point required. With lampshades no more than a couple of inches in diameter there is still plenty of room around the machine for the operator. We will also have a feature on the use of tungsten carbide tooling which will tell you where to get it, how to get it as cheaply as possible and how to get the best from it, and we will discuss which type of tooling to use for a particular purpose to help you get better results from your machining.

Among the constructional projects there will be a tiny hand milling device which is not difficult to make yet will considerably increase the capabilities of any workshop;



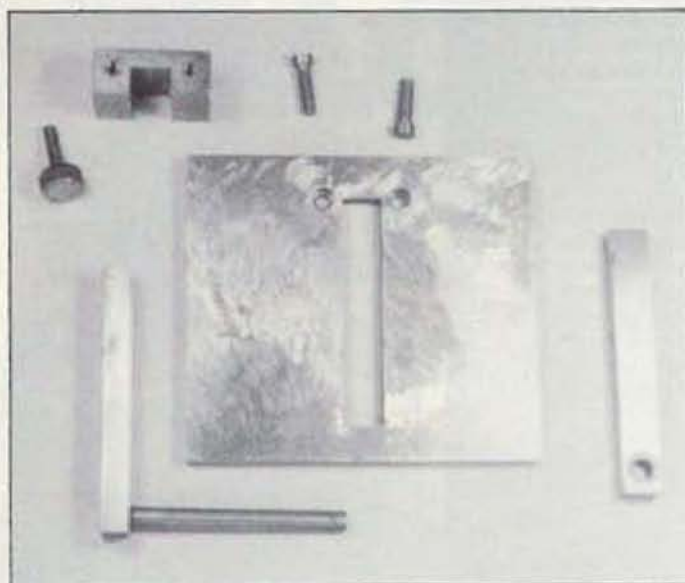
it has been used to mill the flutes in a $\frac{1}{2}$ in diameter milling cutter. Add to all of this a homemade lathe, a gearbox and a special vice, all of which we hope to feature next time, and you will see that our Autumn issue promises to be even more enjoyable than this!

The milling machine (above) will come in for extensive coverage in future issues - as will beautifully laid-out workshops packed with ideas like this.

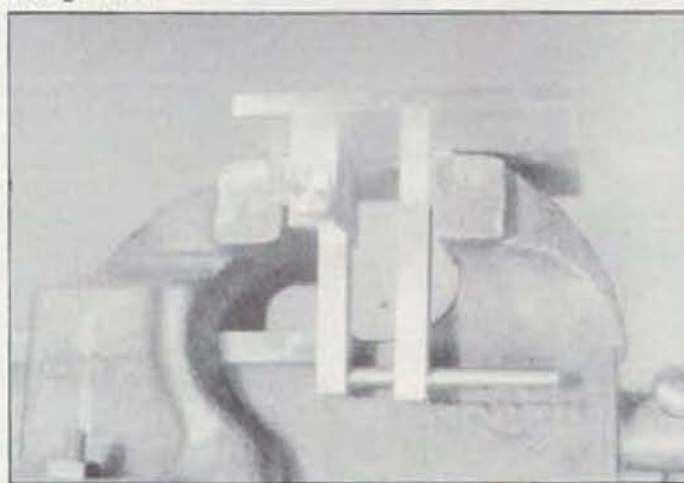


It only remains now for me to say that I sincerely hope that you enjoy our new magazine. Remember, we need articles, feedback, letters and tips from you and if you have anything to offer we would be pleased to hear about it. If you don't have anything that you feel is of sufficient interest for us to pass on to other readers, then just write and tell us what you think of the magazine. Your views are valuable to us and will help us to maintain the high standard that *Model Engineers' Workshop* intends to set.

Stan Bray



At left, the parts for the vice; dimensions can easily be adapted to suit individual needs. Below, the plate vice viewed from underneath; main vice jaws automatically close it up as they are tightened



There must be many occasions in the productive life of any model engineer when he or she has to grip firmly items which are just too thin to trust to the jaws of the bench vice. Those thin, 'plate-like' components may need to be held firmly for marking-out, polishing or some essential filing or other operation and can easily suffer in the jaws of the normal engineers vice which, in any case, provides

accommodate the variety of thicknesses we have to deal with. The rear jaw is fixed at one end of the slot whilst the other jaw can locate anywhere along the length of the slot. In use the plate sits on the top of the bench vice with the jaws gripped between the jaws of the bench vice. Having carefully adjusted the height of the jaws and the distance between them to suit the component to be gripped, the bench vice is

that the sliding jaw does not bind except when tightened up in the bench vice. You can, as a useful refinement, case-harden the working faces of the jaws but this is not essential to the operation of the vice.

I have found this tool very useful for holding items of even less than 0.01 in. thick, as well as those which are $\frac{1}{2}$ in. or more but which I prefer not to submit to the bench vice jaws. With a little ingenuity

A USEFUL PLATE VICE

Holding small parts in order to work on them, particularly where filing is involved, can be a tricky business. There are various ways of overcoming the problems, but usually tools for doing so are complicated things to make. Alan Buttolph solves the problem here very neatly with a small plate vice that slips into the ordinary vice jaws, and tightens on the work as the vice is closed, allowing the pressure applied to delicate work to be controlled easily. The vice is simple to make, and many readers will be able to construct it from odds and ends found in the workshop.

no support other than the usual clamping action.

I have used the simple plate vice shown in the photographs for a long time now and it has proved invaluable for holding those thin, small and not so small items which we all seem to need to produce at some time. It has repaid over and over again the few hours needed to make it. All components are of mild steel.

How it's made

Essentially, it consists of a slotted flat steel plate of reasonable thickness, in the slot of which are two adjustable jaws. The plate provides a firm support and the jaws the necessary grip for a wide range of thicknesses, lengths and breadths. The jaws are together adjustable for height to

tightened up to close the plate vice jaws on the component, as firmly or delicately as required.

The dimensions I have given are suitable for use with a 3 or 4 ins. engineers bench vice but are by no means binding if you wish to vary them, either larger or smaller. The construction should be rigid and well-fitting, there being little or no side-play with the fit of the jaws in the slot. The plate should not be less than $\frac{1}{2}$ in. thick and after you have cut the slot as carefully as you can it is advantageous to work the top face as flat as possible. Ordinary bright mild steel (B.M.S.) plate is admirable for this purpose.

Ensure that the guidebar is square to the face and length of the rear jaw. It is secured firmly to the rear jaw by riveting over the reduced end. Keep the guidebar oiled so

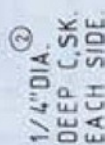
the jaw faces can be temporarily covered with brass, aluminium, cardboard, rubber, etc., either clipped on or stuck on for those special needs which do occur.

A view from above the plate vice. The jaws close though a slot in the top face and tighten to hold very thin work firmly in position.



① PUSH FIT
② SLIDING FIT
③ SLIDING FIT

DIMENSIONS IN INCHES.



100

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GUIDE BAR

① 1999年

2

Tan2B A

A

2 HOLES 28 A.

CLAMP SCREW

PLATE

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A T T A C H M E N T S FOR DIAL TEST

For mechanical accuracy in setting-up it is difficult to better dial test indicators. They can, however, be somewhat awkward to use in certain circumstances. Here, R. J. Loader describes attachments that considerably add to the versatility of the dial test indicator, and will aid setting-up accuracy. The design is basically very simple and well worth exploring for the benefits it will give.

One of the most useful instruments a model engineer can have is a dial test indicator (d.t.i.) – sometimes called a dial gauge or clock. It will check a lot of things: alignment, parallelism, concentricity, roundness and squareness, to name a few. I am lucky to have one, given to me by a very good friend, but there is one big snag, there are no accessories and without them the

usefulness is at least halved. A dial gauge when bought (or given) is usually just that, the gauge only. It takes a big pocket to equip it with all the extras. My pocket is quite small and I am reluctant to buy what I can make, so I have recently made some attachments to make the dial gauge more useful.

Let us be clear first about which instrument I mean. I know that we call

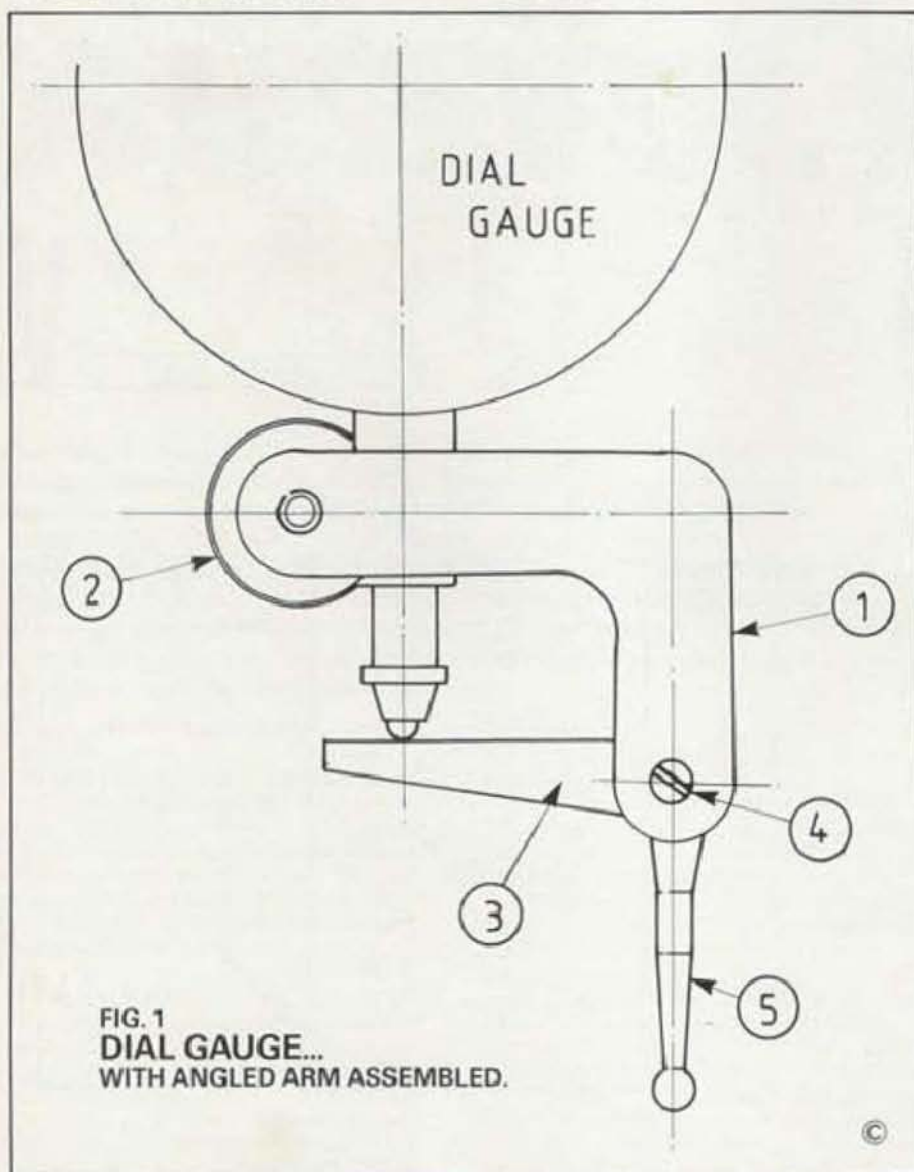


FIG. 1
DIAL GAUGE...
WITH ANGLED ARM ASSEMBLED.



Drilling the bracket which is held in a large toolmaker's clamp while the operation is carried out.

anything which does the job a d.t.i. or a 'clock', but we only do so for the same reason that we call a vacuum cleaner a 'Hoover'. What I mean by dial gauge is the one with the big clockface operated by a plunger and gearing.

The things which are most difficult to do without attachments are checking small holes and internal features, lining up shallow projections like the fences on my milling table, and setting vice jaws true. I know that there are ways of getting round these jobs, but they take time and often mean hunting for bits and pieces.

Making the components

All the components can be made using a small lathe, a drilling machine and files, drills, taps and dies, a couple of reamers and a hacksaw or junior saw. It is a useful exercise in marking out, fitting and turning. For convenience, I worked in Imperial sizes, but it can be converted easily into metric if necessary, all but the $\frac{1}{8}$ in. hole in the bracket. Fig. 1. shows the assembly.

The largest component is the bracket, shown in Fig. 2., which fits over the stem of the dial gauge, clamps to it and holds the pivoting arm. I used a piece of duralumin, which was close to the size I was looking for and had a hole drilled in the right place

E N T S



Filing the slot in the bracket to accommodate the arms. If milling facilities are available, they can be used for the operation.

so that I didn't have to file the internal radius. Mild steel could be used instead, but if it is, I would suggest drilling some holes in it, to reduce the weight a bit. Use duralumin or a similar alloy if possible; it is nice and light and easier to cut and shape, especially if, like mine, your equipment is a bit limited. I milled enough of it to establish accurate data and filed and hacksawed the rest. The holes were drilled with the lathe drilling head, the largest one $\frac{1}{2}$ in., leaving 10% of the diameter for the reamer to take out. I reamed it by hand because reaming that size in my lathe tends to stall the motor. The 2 BA tapping hole was drilled No. 25 and the clearance $\frac{1}{8}$ in., approximately halfway through. The 6 BA tapping drill was No. 43 and the clearance No. 30, clearance drill again taken halfway through.

The slots

The slots were then marked out and cut. They can be milled, but I find it is quicker to do jobs like that by hand. The slot which goes through to the  in. hole is only for clamping, so a hacksaw cut was all that was needed. My bracket has slots of the same size in both positions. I blame Mr. Puccini for that, because it was a particularly beautiful part of one of his operas that I was listening to at the time – favourite background music when I'm working, but normally turned off when I've got to concentrate. I was listening more than concentrating; there must be a moral somewhere . . .

The important slot is the $\frac{1}{2}$ in. one and it needs a lot of care. A good way to rough it out is to put two hacksaw blades in one frame, two new ones if possible, if not, two equally worn ones. This will give quite a wide slot and a good start for filing. The best files to use are, a 4 or 6 in. warding file for roughing and a 4 in. smooth hand file for finishing. The 4 in. hand one is about 0.006 in. less than $\frac{1}{2}$ in. at its thickest, so by the time it is working freely in the slot there won't be much to come off. If Swiss Files *must* be used, choose one with the coarsest cut.

I used a piece of the $\frac{1}{8}$ in. strip used for the arms to gauge it with, filing gently till it was a free fit without wobble. I filed the depth to $\frac{1}{8}$ in. to allow the arms to tilt enough. After the slot was finished, I tapped the holes, entering the tap through

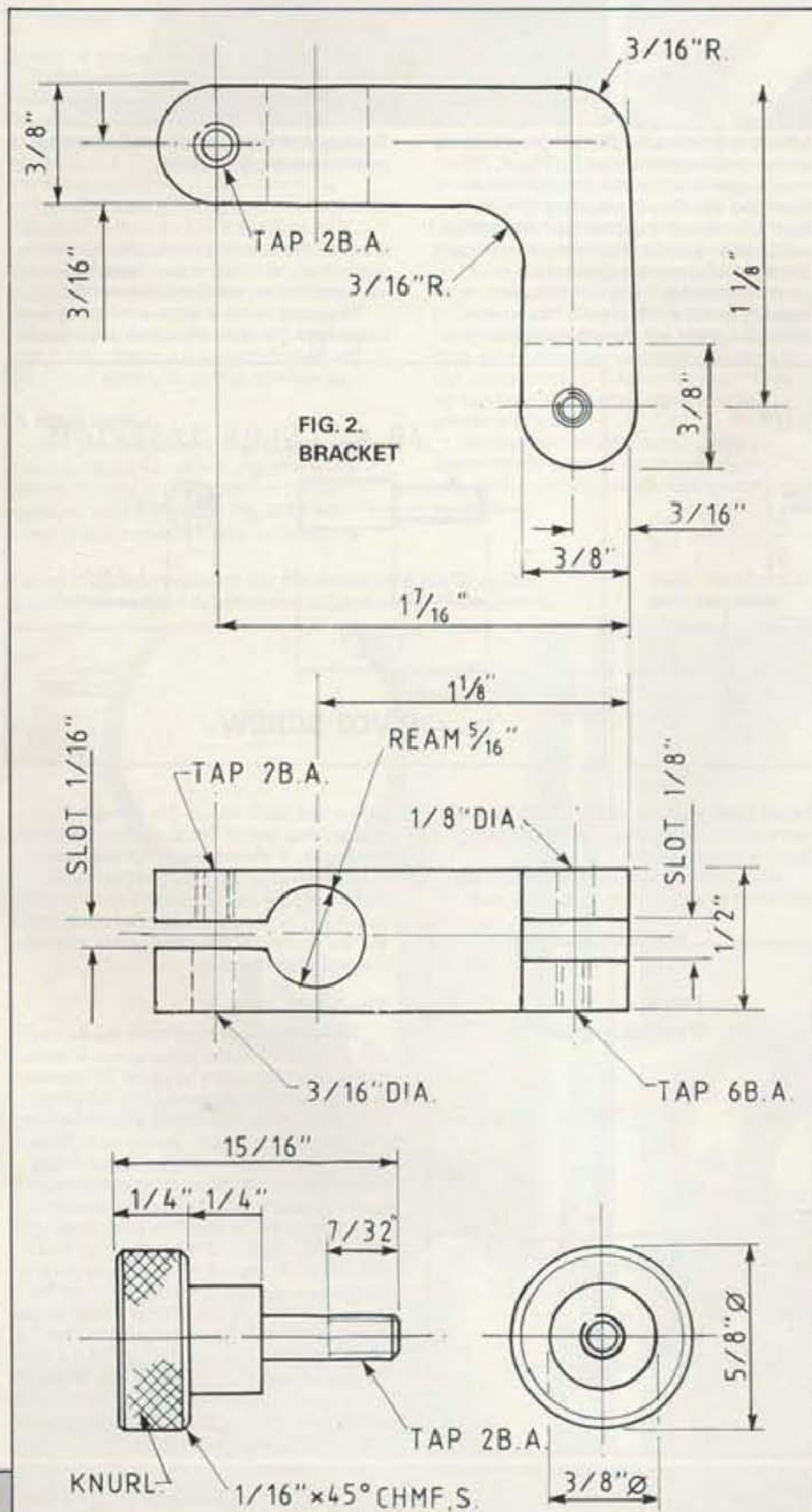
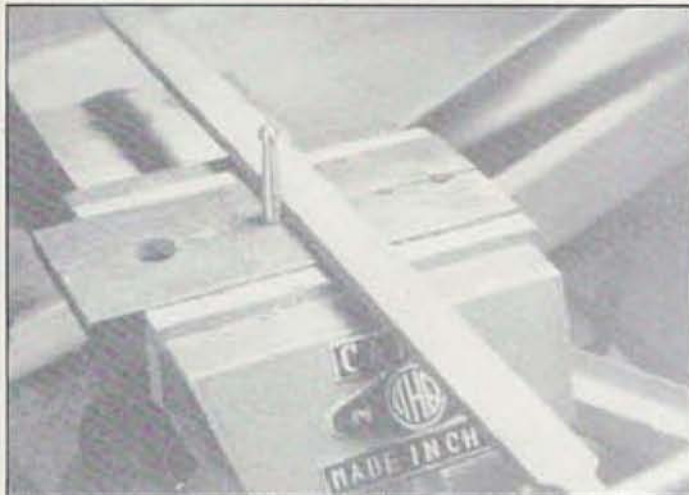
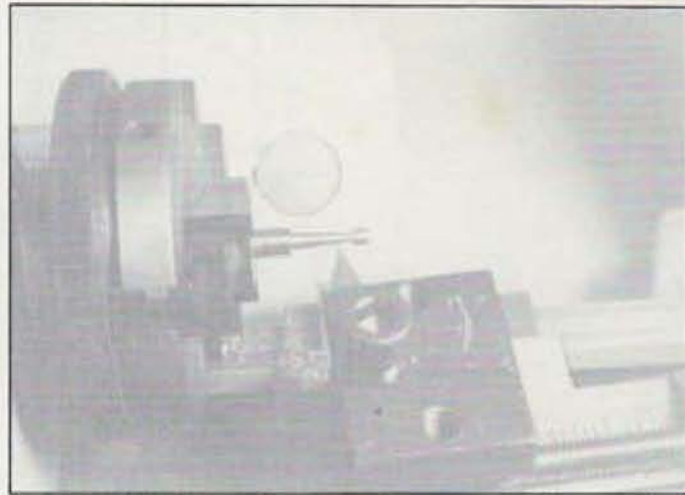


FIG. 2. CLAMPING SCREW



Using a sprung thread plate to work on the stylus. The plate consists of a piece of steel about $\frac{1}{8}$ in. or 5mm thick with a series of different-sized tapped holes. This is sawn through the centre to split the holes. Components can be screwed in and, when the plate is tightened in the vice, they are held firmly in position.

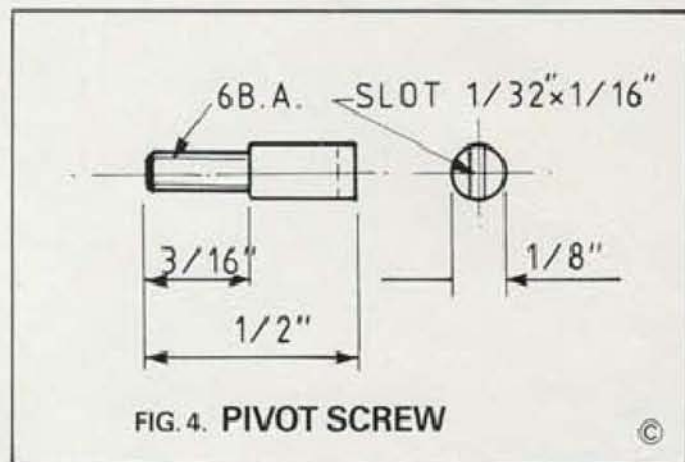
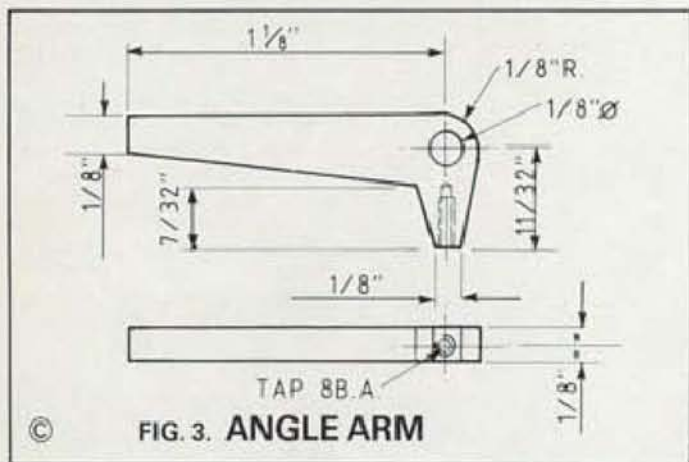


Turning the taper on the stylus, which is now nearing completion.

following it with a No. 50 drill $\frac{1}{8}$ in. deep, as shown in the scrap section in Fig. 4. This makes sure that the stylus thread will fit flush and also that the tapping drill is at least $\frac{1}{8}$ in. deeper than the tap needs to go. I used the smallest available tap wrench and plenty of lubrication. I ignored the recommended tapping size because tapping an 8 B.A. blind hole, I needed all the help I could get. Two things which will

checked the fit in the slot in the bracket again. They all fitted, if they hadn't I would have worked on the arms, not the slot.

The pivot screw was no problem. It was made from $\frac{1}{8}$ in. diameter silver steel like all



the clearance holes, which helped to keep it nicely upright. I filed the radii on the ends last, then thoroughly deburred the holes, finish filed the surfaces and took off all the sharp edges. It doesn't matter if all the edges have a small radius.

break small taps are, using a tapping drill too close to the core diameter and using too big a tap wrench.

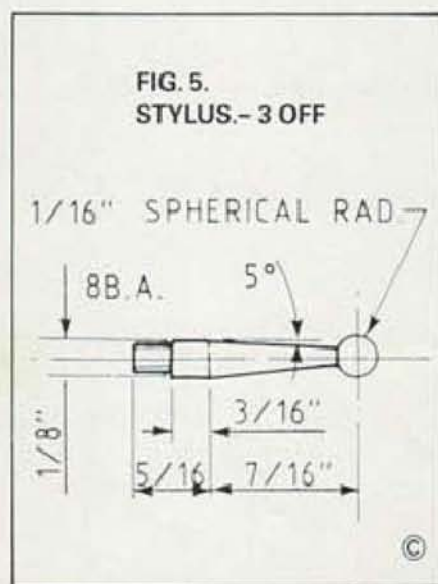
After all the holes were tapped, I filed the arms to shape, deburred them and

the turned parts except the clamping screw, I had one of those ready made from duralumin. If silver steel is not available, mild steel would do; if it could be case hardened so much the better, the clamping screw too, could be made from mild steel. I left the slotting of the pivot screw and did the rest of the turning.

The arms

The arms were next, three of them, one angled and two straight ones, shown in Figs. 3, and 4, 6 & 7. The long one is an extra, intended for a really long reach and can be left out if it isn't wanted. Each one is made from $\frac{1}{8}$ in. mild steel stock strip. The marking out, drilling and tapping of the 8 B.A. holes is the most important part and should be done before any cutting out of shapes; it is easier to mark out and hold the pieces if they are still in parallel lumps.

Drilling and reaming the $\frac{1}{8}$ in. holes is straightforward. I used a No. 33 drill for the reaming size, the usual 10% allowance, then I started on the 8 B.A. holes. I made sure that the marking out and centre punching was as close as possible in the middle of the $\frac{1}{8}$ in. dimension in each case; a watchmaker's eyeglass helped. They were drilled in a vice and checked for squareness with a square against the datum edge. When I drilled them, I started with a $\frac{1}{8}$ in. drill $\frac{1}{8}$ in.



The styli - Fig. 5

The styli were turned from the same $\frac{1}{8}$ in. dia. silver steel as the pivot screw. A lathe tool with a plan angle of about 30 degrees is useful, if not a screw-cutting tool. The spherical radius was left as a short section $\frac{1}{8}$ in. long, and filed and stoned to its final shape. The 5 degree angle was cut using the compound slide, starting at the chuck end and working back. The one shown in the photograph is ready for final shaping. When the shank and the radius had had a last polish, it was cut off at about $\frac{1}{8}$ in. long. Holding on the $\frac{1}{8}$ in. diameter, I turned the diameter for the 8 B.A. thread a little longer than it needed to be and made the first $\frac{1}{8}$ in. or so 0.070 in. diameter. This gives the die a good start and should keep it true. After all the turning and threading was done, I faced off all the extra length and chamfered with a fine Swiss File. I made three styli, but two

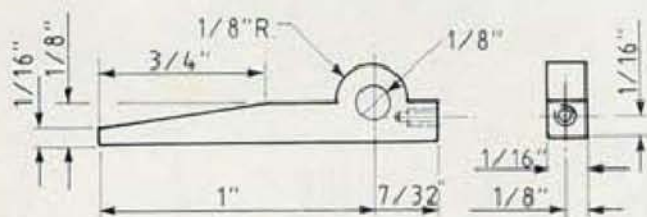


FIG. 6. SHORT ARM

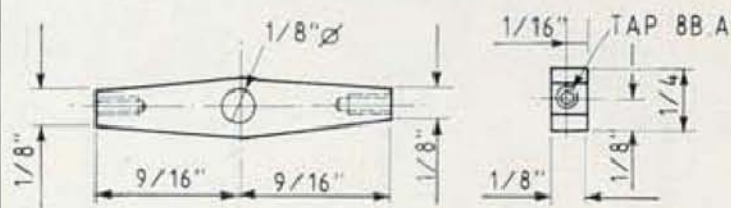


FIG. 7. LONG ARM

would be enough, one each for the angled and short arms and they could be unscrewed to use in the long arm. I made the extra one because they are easily lost.

The styli should screw into the arms nicely and, if you have strong fingers, no more need be done. If you want to be certain that they go in tightly, small spanner flats can be filed on them to take a 10 B.A. spanner or a home-made key. I did both this and the slotting of the pivot screw using a sprung thread plate, which I use frequently for holding threaded work. Be careful if you do put the flats on; I found that it only needs a few *light* strokes with the file on each side for the spanner to fit.

A final extra

The last component, Fig. 8., is another extra. If the stylus on the end of the dial gauge plunger is unscrewed, it can be replaced with the probe, Fig. 8., or any other shape needed. I have included the

probe because it will get into places otherwise very difficult to get at. The dimensions are arbitrary, except for the thread, which is 6 B.A., and can be made to any length or diameter. What I have mainly used it for is finding the depth of square and acme threads, where the stems of other instruments are usually too large.

When all the components were finished, I hardened those made of silver steel and oil-blackened the mild steel ones. I have a large coffee jar half full of quenching oil and the use of the gas stove, good enough for small jobs. If you do the same, choose a time when food preparation or cooking is not being done, and *ask permission first*, oil-blackening especially, makes a bit of smoke and smell.

As the photographs show, these attachments are well worth making and extend the usefulness of a dial gauge no end.

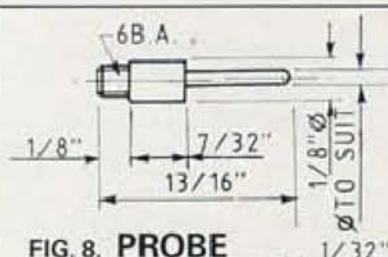
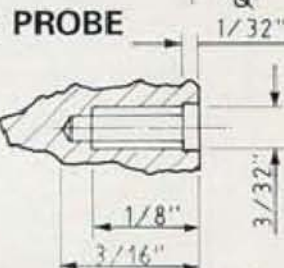
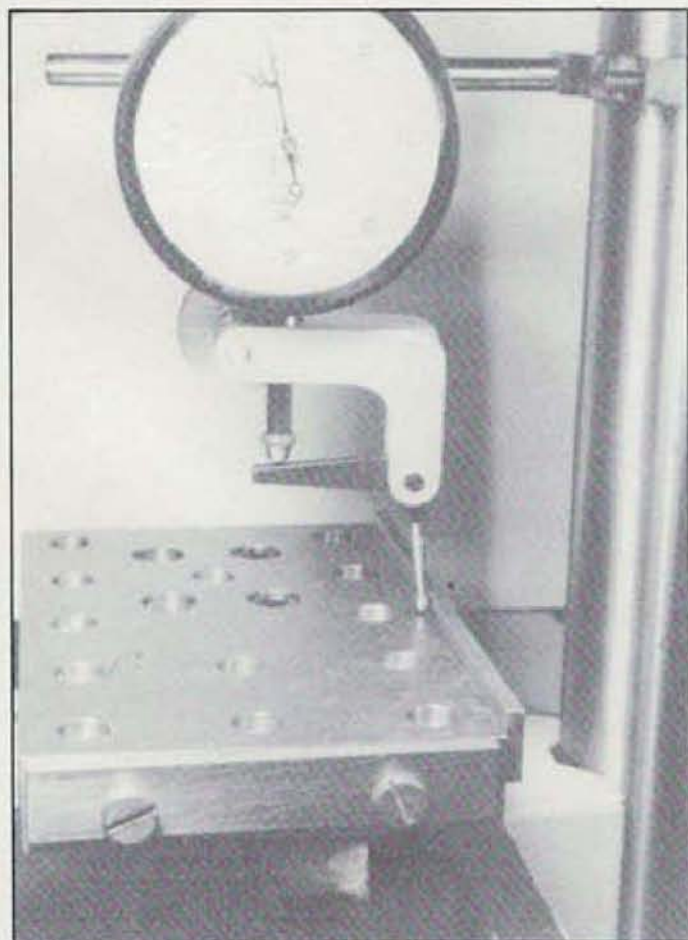


FIG. 8. PROBE

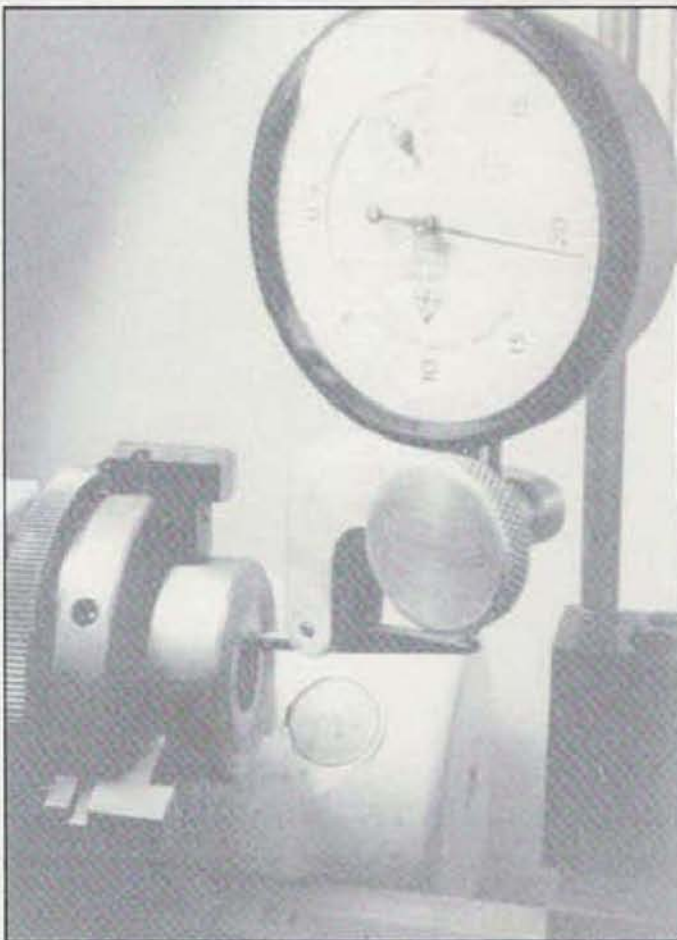


SCRAP SECTION ON ALL 8B.A. HOLES.

Using the attachment to set the fence on a milling table parallel. The stylus is set in the angle arm for the purpose.



Here, the short arm is in use to set a bored component concentrically.



TRY SQUARES WITH A

D I F F E R E N C E

There are three types of try square shown in the engineering suppliers' catalogues in France, which are typical of equipment used in that country. Whilst there is nothing at all wrong with the normal type of familiar square, these French types do offer some advantages when marking out. They are called *equerre simple*, *equerre a chapeau*, and *equerre double onglet*. Simple translations would be: simple square, square with a hat, and double angle square! All these are of the same type of construction and so I have limited the description to the *equerre a chapeau*.

All the squares are made of the same thickness of material and work out to 5mm thick which, after finishing, means around 4.2mm, this material being used for both blade and stock. No matter how large (and some are as big as 300mm — (approximately one foot) there are only two fixing screws.

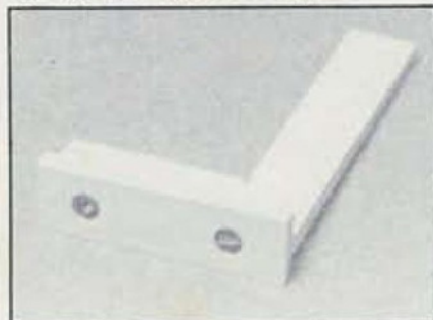
The screws are 3mm diameter and, in some cases, the countersunk heads are reduced in size to prevent them breaking out of the edges of the material. Using this size of screw in such a material thickness will call for great care in marking out and drilling the tapping sized holes. These holes are also blind, so there is a danger of taps being broken if care is not taken. Plenty of tapping compound should be used and at the first sign of tightness the tap should be withdrawn.

The proportions of blade to stock follow

This photograph shows two sizes of the typical 90 degree square.



The finished 'Equerre a Chapeau'.



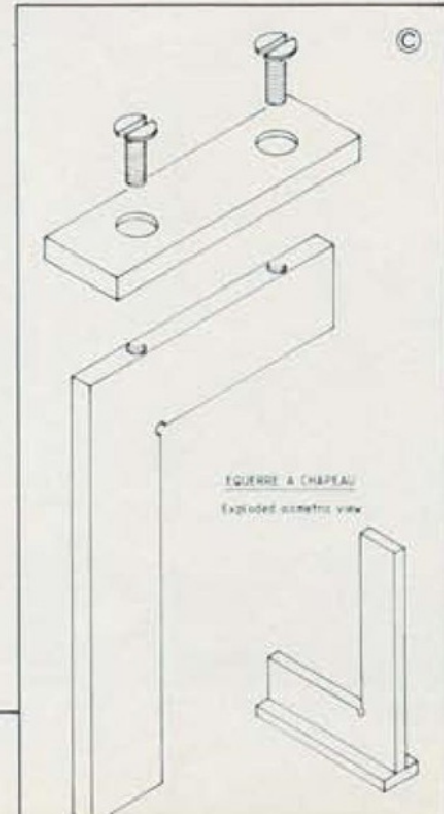
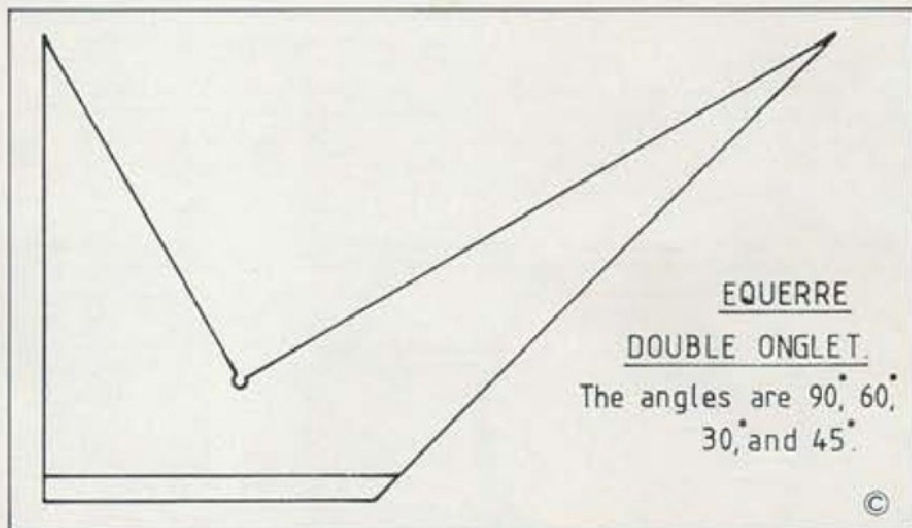
This little article by R. Wallman illustrates how even common engineering practices can differ in detail from country to country. Here he describes the popular type of try squares used by French craftsmen and supplies drawings and hints on how to make them.

the ratio of the square root of five plus one, divided by two. Care must be taken when cutting out, as distortion is likely to occur. One way to off-set this is to partly cut the

be to suit the individual; my own squares are ground to a satin finish. Readers without facilities for this can use a range of fine emery papers to get a smooth surface.

Other types of square, if that is the name which refers to them, are to be found in the catalogues. The *equerre a talon*, *equerre a 120 degrees*, and *equerre a 135 degrees* are all amongst those so listed, but I have never yet seen them in use.

I do not intend this article as a treatise on square construction but offer it merely as a point of interest for those who like making their own tools and to show how practices can vary from place to place.



material to shape and leave it for a while to allow stresses to be relieved, then complete the work afterwards.

The ninety degree square, as the photographs show, is made by marking out and drilling a hole at the corner of angle. The metal can then be cut both ways into this. The work can be milled to a finish if suitable facilities are available, otherwise it is an excellent exercise in filing. Constant checking for accuracy is essential.

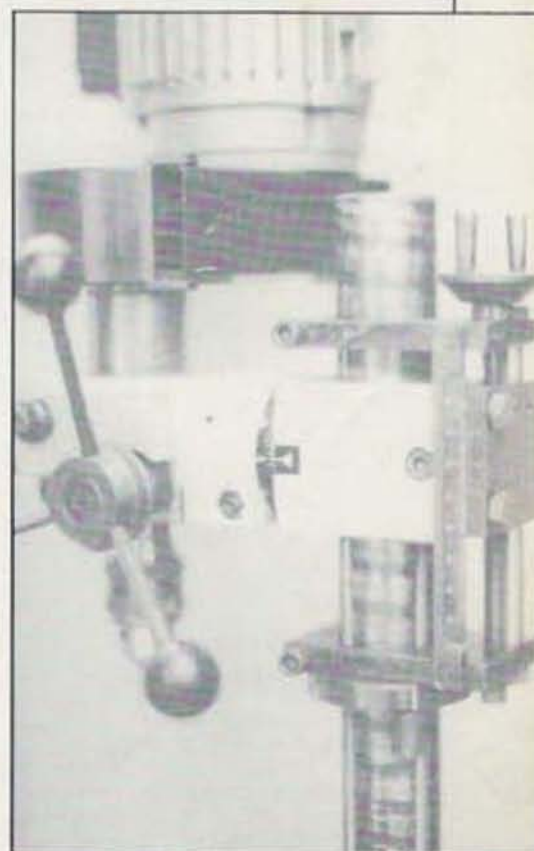
The stock and blade should be drilled, tapped and joined together and then finished afterwards; this will allow for any slight errors in marking out. Final finish can

MILLING HEAD MOD FOR THE COMPACT 5

Whilst Mr Farrugia describes these modifications with the EMCO Compact Five milling attachment in mind, with alterations to the measurements the design would suit almost any milling attachment mounted on a round column, such as the Unimat 3, and other makes as well. Basically, the modification allows accurate measurement of the vertical travel on the head when it is set at an angle and, probably more important still, the head to be moved to change cutters without losing the setting. Good, accurate machining is called for but no castings are needed as the device is made entirely from stock materials.

Although the basic EMCO Compact 5 and Compact 8 lathe systems are quite versatile as they stand, for performing co-ordinated machining

operations one would perhaps require additional features to allow the whole process to be executed with one workpiece setting, enabling maintenance of specific



The modification, which increases accuracy, could be applied to any similar machine.

important data relative to the workpiece edge/s since its set-up will not need be disturbed.

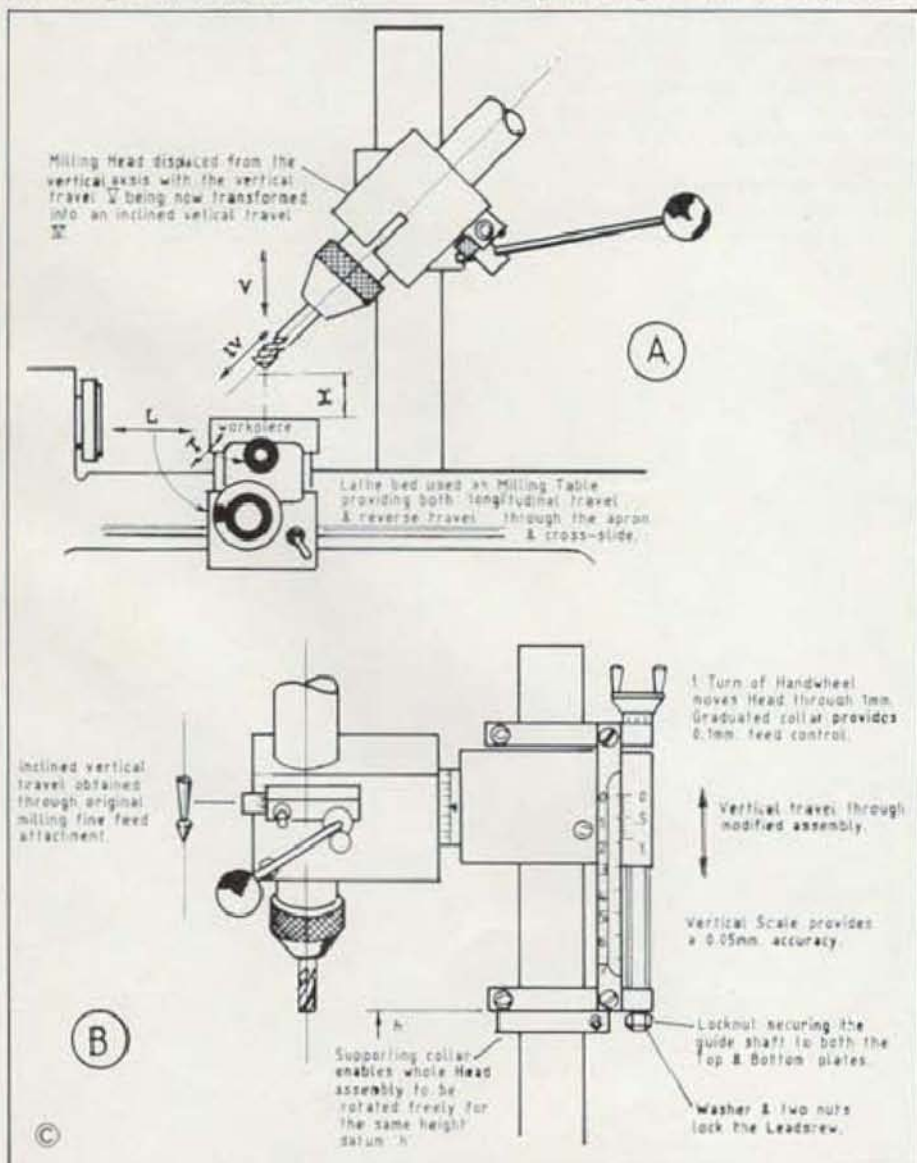
Having the EMCO Compact 5 milling head mounted on the Compact 8 Lathe bed, I have encountered this situation many a time, sometimes fortunately visualised prior to job set-up, while in other instances only when the operation has already been initiated, with frustrating consequences.

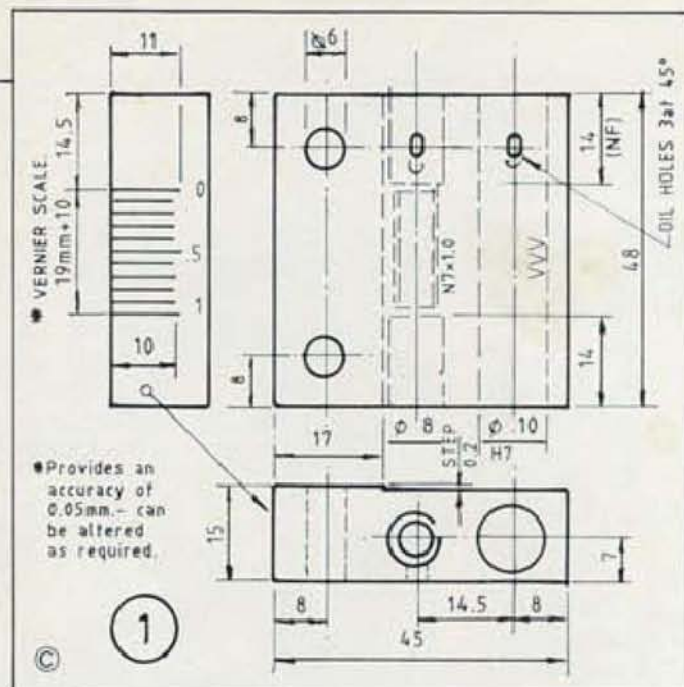
A shortcoming of the system is that when the milling head is swivelled about the vertical axis and thus displaced from it, the resulting sleeve feed would be only that inclined to the vertical, thus practically losing the actual vertical feed capability. This can be easily visualised by referring to **diagram A**, eliminating the need of lengthy descriptions. Therefore, one can deduce that, to feed the cutter edge through a vertical distance 'x', a complex operation would result, with the actual net movement having to be achieved through two separate adjustments — one via the inclined vertical 'IV' and the other via the longitudinal axis 'L', which necessitates geometric calculations with the inherent accuracy losses.

The modification effected to do away with this is depicted in its general assembled form in **diagram B**, which shows that, for any actual milling head displacement, full control of the vertical displacement is now still obtainable, thus enabling co-ordinates about a particular datum to be maintained.

Degree of accuracy

The accuracy of the vertical feed control achieved with this modification is in the order of 0.05mm using the vernier on the block, and 0.1mm only if using the





graduated handwheel collar.

However, one can easily modify the levels of accuracy required by altering either the leadscrew pitch and consequently the corresponding handwheel collar graduations, or by changing the vernier design. Nevertheless, the 0.05mm vernier was chosen due to its good readability inherent to its wide spacing and also as it has proven itself quite adequate for most precision jobs.

This modification is of no particular benefit to anybody utilizing a separate milling table capable of vertical travel adjustments, the whole idea behind this job is to enable the same result to be obtained without having to complicate the workpiece mounting set-up, thus using only the basic EMCO system (for those who already have it) with a normal machine vice directly clamped on the cross-slide yet now achieving four different travel axes, namely, the longitudinal 'L' (along the lathe bed) and the transverse 'T' (across the lathe bed), both in a horizontal plane through the lathe's apron and cross-slide assembly; the vertical 'V' and the inclined vertical 'IV', both in a vertical plane through the milling head.

Without this modification, the inclined vertical feed 'IV' is always available, however only at the expense of the actual vertical feed 'V', which, for accurate dimensioning and other geometric reasons, is indispensable for specific operations.

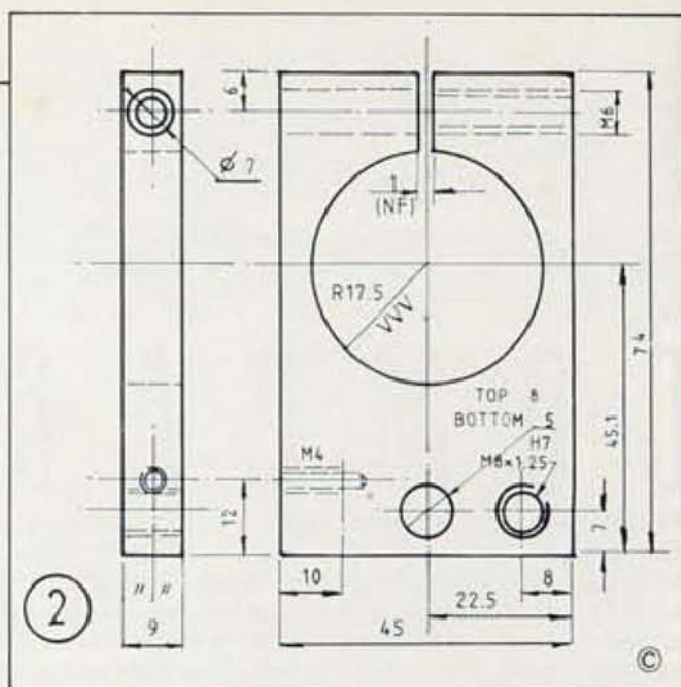
Parts and assembly

To manufacture the whole unit, eight main items are required, demanding precision in dimensioning (denoted in the parts scaled drawings by the symbol *v*) and the finest finish possible to result in a smooth operation when assembled, so that it would only require an even application of pressure at all stages of the allowable travel limits in both directions when feeding or withdrawing the head via the leadscrew.

The top and bottom plates (parts No. 2) and the supporting collar (part No. 8) all have a large hole of the same diameter which should run a sliding fit over the milling head shaft in hand (thus the diameter dimension might require adjustments with respect to the supplied specifications just to suit the shaft available), such that it would only require a

slight tightening force on the respective clamping bolts in order to secure it in position, without giving way to misalignment when tightened. The clamping bolts used are standard M6 with an Allen head to facilitate the process — thus using the same Allen key throughout the whole system.

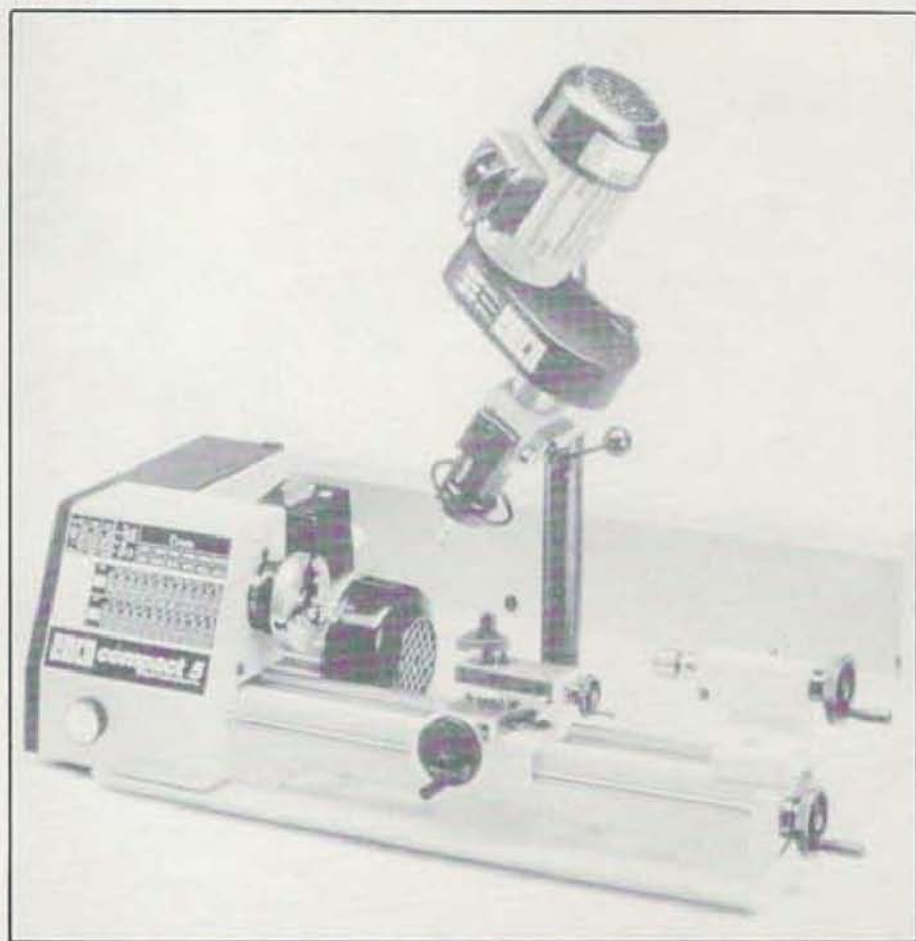
The purpose of the supporting collar is to enable the whole milling head assembly, when modified, to be left loose and be rotated about the milling column (the electric cable permitting) thus enabling cutter changes and other operations being executed without losing that particular head setting (diagram B) over the column, datum 'h'.



The guide shaft

The guide shaft (part No. 4) must slide fit in the threaded block (part No. 1) with the maximum alignment possible; care must be exercised when boring the 10mm diameter hole in the block, for if the hole axis is misaligned with respect to that of the shaft between the top and bottom plates, then it will lead to jamming of the system. Slight misalignments can be compensated for by shimming the block

Standard Emco Compact Five lathe with milling attachment.



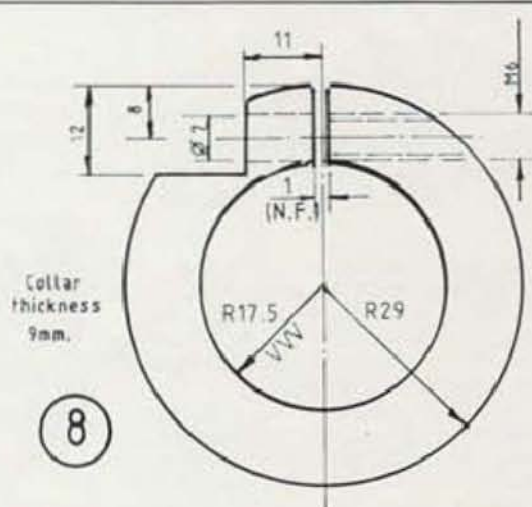
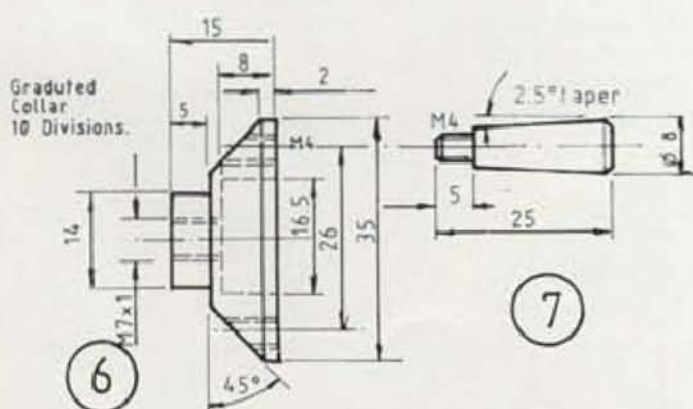
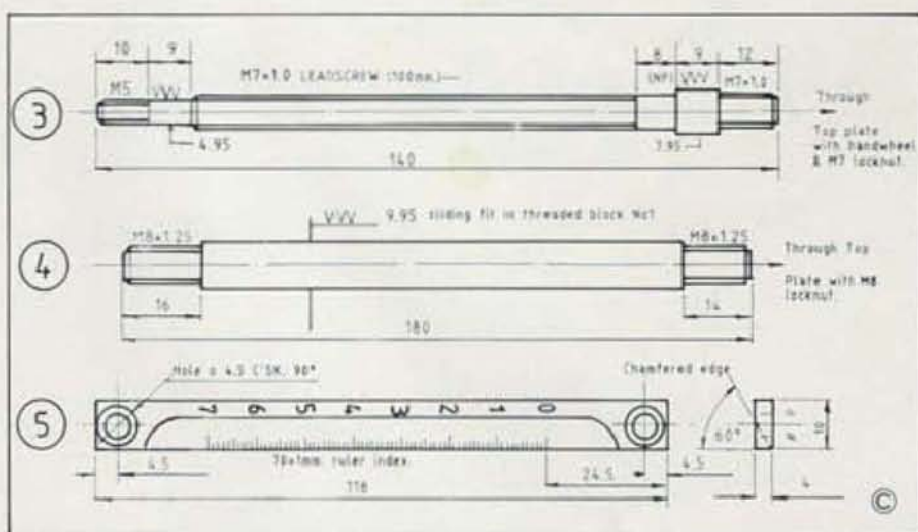
From Peter Jones comes the following hint: To model engineers who are partial to a pickled onion, I say keep a spare jar handy in the workshop and strain the superfluous liquid from the onions into it. This makes an excellent pickle for brass and copper. I claim the prize for the most blindingly obvious suggestion ever made!

The guide shaft is first threaded and locked to the top plate with an M8 nut, then fed through the block, threaded again through the bottom plate and locked in the same manner as for the top plate, but with the difference that it cannot now be driven fully home through the bottom plate since alignment of the plates' shaft holes is essential — so before tightening the bottom plate, pass the whole set-up over the milling head shaft, align the plates and then tighten and lock with the M8 nut, ensuring that after tightening, both plates will remain aligned and thus run quite freely, but not loosely.

Next fix the handwheel (part No. 6, complete with the drive pins, parts No. 7) to the leadscrew (part No. 3) locking the handwheel with an M7 nut. Pass the

The last item is the ruler (part No. 5) to be bridged between the top and bottom plates, providing a read-out against the vernier scale on the side of the leadscrew.

All parts, except the guide shaft (4), are finished by heating and blackening in thick oil. The vernier and ruler graduations, as well as the handwheel collar markings are then finished in white (wiping off white wax or paint before it completely dries) and protected from chipping off by applying an even polyurethane plastic film. Wherever (NF) appears against a dimension, it denotes that the particular dimension is Non Functional; i.e. it can be altered to suit the machining process and tools as required.



MATERIAL-ALL MILD STEEL.FINISH, BLACKENED IN OIL.
NF-NON FUNCTION DIMENSION VVV-PRECISION FINISH.

THE UNIVERSITY OF CHICAGO PRESS

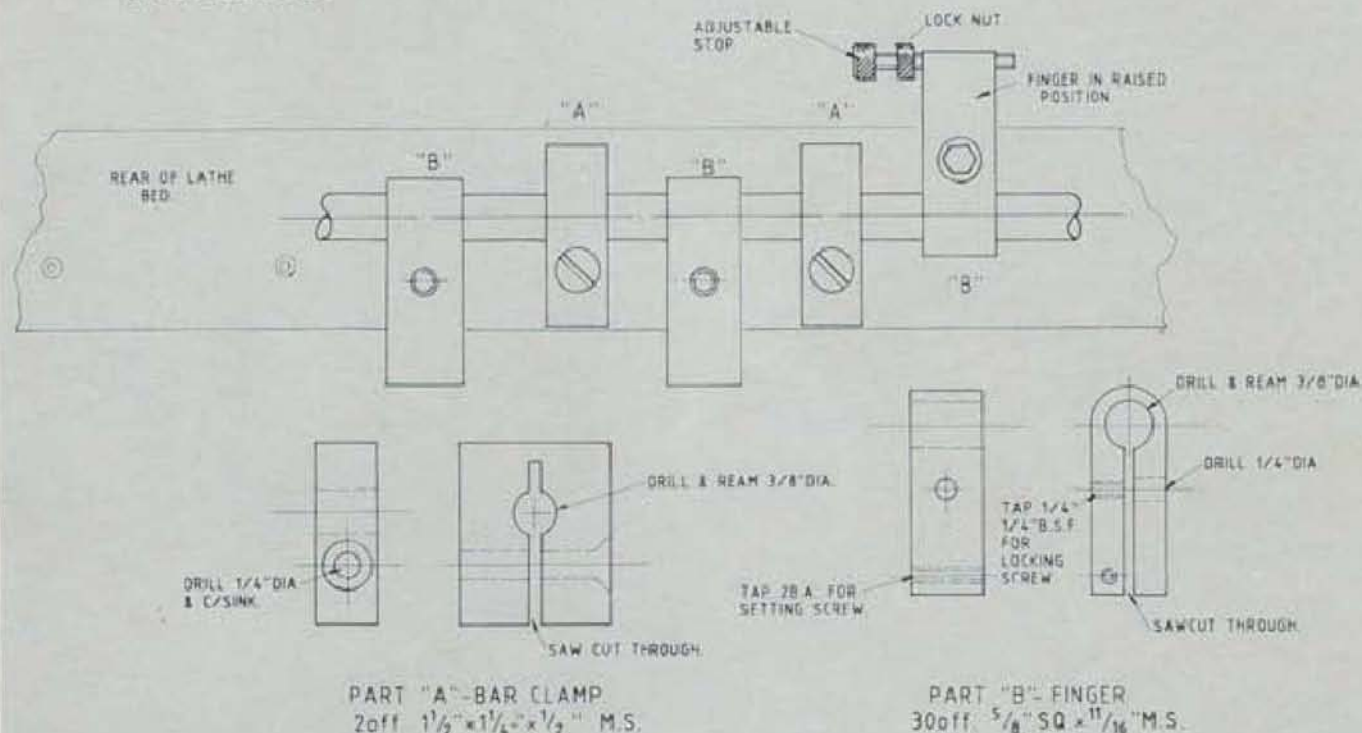


Without a saddle stop, boring a smallish blind hole to a fixed depth is a 'dicey' operation, (yes I know there are such things as 'D' bits, but unless one has the correct size, making one takes longer than boring a hole).

Without a stop, the usual way of boring blind holes, is to stop the lathe, feed the tool into the hole until the end of the hole is

With a cross slide stop once adjusted, it is just a matter of putting on the cut with the leadscrew handle and feeding the cross slide in and out without having even to look at the micrometer collar reading or count turns.

SADDLE STOP



The parts for the cross-slide stop.

The photographs and sketch really explain everything, but here is a brief description of how it is made.

A 4 in. length of mild steel is end milled to the cross section of a tee nut, for extra strength I made this part stand up higher than the cross slide which necessitated the saddle shaped items that fasten it in place in the tee slot. The shaped piece on the end was riveted and silver soldered in position and tapped 1/4 in. B.S.F. for a length of screwed studding.

The part with the open ended slot shown clearly in both photographs is a piece of angle sitting over the gap in the lathe bed. Riveted to it is a 1 1/2 x 1 1/2 x 1/2 in. thick piece of mild steel accurately fitting the gap between the lathe shears. This assembly is clamped in place along the bed with a keep plate loosely held in place with the cheese headed screw as shown in the photograph.

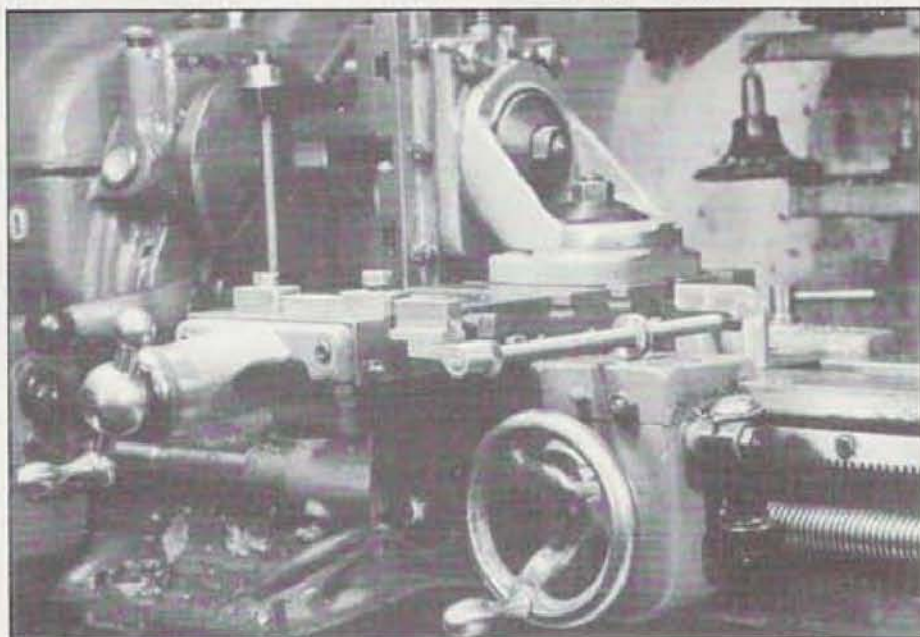
This keep plate is made to drop through the gap in the bed and, by turning it a

quarter turn, the slotted angle can be securely held in place by two 1/4 in. B.S.F. cap screws, also shown in the photographs.

Adjustable knurled nuts and lock nuts on the screwed rod either side of the slotted angle enable the movement of the cross slide to be accurately controlled. It will be seen that the screwed rod is free to move along the slotted angle as the cut progresses.

The device can be easily made from bits from the scrap-box, with no mutilation of the lathe, it is quickly fitted and is precise in its action.

The cross-slide stop in position on the author's Myford Lathe.



Many people probably will have looked at the drawings of the larger traction engine miniatures published in the *Model Engineer* from time to time and decided that some components were just too large for their equipment and turned to other things. It is my purpose in this article to describe how a former locomotive builder tackled and overcame one of the more fundamental differences between traction engines and locomotives.

Whilst the general run of traction engines have similarities with the locomotives — a boiler of the same classic Stephensonian type, cylinders, valve gear and various accessories — the details are certainly dissimilar.

Traction engines

A locomotive builder contemplating constructing a traction engine of around 2 in. scale is faced with a number of outstandingly different problems than those encountered previously. The sheer size, in terms of diameter, of some components are a major hurdle to those of us whose lathe is the ubiquitous 3 in. type; mine is a Myford Super 7 and what follows is relevant to the very many brands of machine of this capacity.

At first sight of traction engine drawings, the most outstanding items are the final drive gear, hind wheels and flywheel. Further examination will draw attention to the size and shape of the cylinder block.

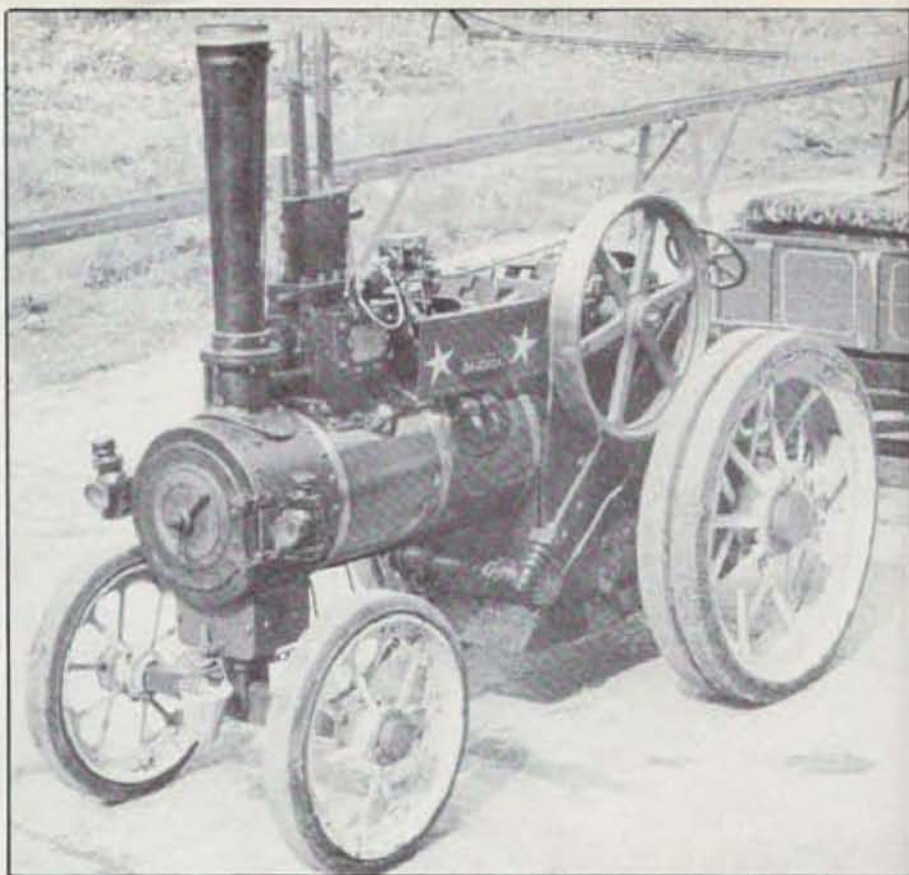
Wheels

Wheels may be fabricated using the well proven methods propounded by the late W.J. Hughes when describing *Royal Chester* which give very good results, or machining can be contracted 'outside'. Some rims are available requiring no machining, the easiest of all. No tremendous accuracy is called for with these slow-moving components. Strength, to say the least, is ample; and normally, appearance is the most important criteria.

Flywheels

Flywheels, depending upon whether spoked, solid, or dished, ought to be machinable if the lathe has a gap bed allowing the diameter to be swung. My Super 7 has handled the outside and rims of a 9 in. dished Fowler flywheel using the faceplate for roughing and boring then finishing on a nutted spigot in the mandrel. It would be dishonest not to state that chatter may be expected or that no special tooling is needed, especially for the rear of the rims, but it can be done. Chatter marks on the rim sides may be dressed off carefully using a file, dimensions are of less importance than appearance.

There is much to be gained in dealing with these types of casting by the method of removing most of the metal at one



Machining the components for a large scale traction engine such as this can be difficult on small machines. This article describes a way around some of the problems.

setting then removing from the lathe for a period in order to allow stresses to relieve. For solid or dished flywheels an annealing process consists of heating the semi-machined casting to a black heat and as slow a cooling as can be arranged accelerates the relief process. In any event, a delay of a week or two between operations can only be beneficial.

Another advantage is that with only small amounts of metal to be removed, driving arrangements on the lathe can be lighter, obviating any risk of distortion caused by heavy clamping, the spigot is ideal in these circumstances.

Gears

Final drive gear blanks, if cast, require a generous allowance upon the periphery to allow removal of any porosity, sand inclusions and the like. An 'outside' roughing operation to allow finishing in the workshop lathe may again be the answer, with the consolation that someone else has had to deal with all the rubbish.

Night classes can be used where available to perform these tasks and with forward planning to ensure suitable workholding equipment, tooling and so forth, many of these jobs could be completed over a series of evenings.

In this article, C.S. Bamford relates his problems in machining the components for a large-scale traction engine on a small lathe, and how he overcame them. Many readers will have had similar problems from time to time and may like to read of another's exploits. When it came to the cylinder block, this was specially cast for the writer in two pieces. Although it is unlikely that all readers will be in a position to get this work carried out, a normal cylinder block could, however, easily be split on a large band-saw. If one is not available in the home workshop (which seems highly probable) a local engineering works would almost certainly be willing to quote for sawing through it, and the work should not be too costly. More adventurous readers will, no doubt, wish to consider the possibility of sawing the casting with a hacksaw — a time consuming but practical idea if plenty of care is taken in the process....

**A Q U A R T
INTO A PINT POT**



especially where larger machine tools are installed; roughing one session and finishing another, or special arrangements might be made for a longer stint.

Cylinder problems

Cylinders however are a different proposition. Compared to even 7 $\frac{1}{2}$ in. gauge loco cylinders they are chunky, oddly shaped lumps of iron, especially for compound engines and, at first glance, may appear to present insuperable difficulties for turning upon the class of lathe under discussion. The major difference is the curved flange to seat upon the boiler shell which will prevent offering the bore or bores to the tool in the normal manner.

Alternative resources may be used where available but cylinders require to be dimensionally accurate and usually, excepting the bore, there is not a great deal of surplus material to remove. Ideally, bore and other surfaces relating to them need setting to ensure the utmost truth and accuracy and are not conducive to repeated setting and resetting. Cost would preclude

outside machining for most of us and, personally, I prefer to retain control over such complex components and offer my solution to the problem as one way of achieving the required result.

Basic parameters to be aimed for are that bores are to diameter and parallel throughout their length, and to each other if more than one and correctly spaced in relationship to other machined areas. Bore ends must be true to axis, especially the slide bar end and the curved flange to be correct in relationship to bore and boiler centre lines. This is a vital requirement to ensure the eventual truth of crankshaft journal to big end relationship.

To guarantee this sort of accuracy I prefer to use my Super 7 as a horizontal borer using the cross slide as the boring table. As an aside, and not as a Myford shareholder, this machine was purchased in Africa in 1965, travelled to the U.K. in 1968 and to Australia in 1972, all in the original packing case. Having been well used, but not abused (well, not often), it is still easily capable of work to toolroom standards.

For my cylinders the limiting factor was the 2 $\frac{1}{2}$ in. height of lathe centre above cross

slide surface. Obviously, other makes will have different dimensions but the principle remains. Thus a surface is required to allow the block to be clamped so that lathe and bore centre lines coincide.

Locating upon the port face to an angle plate or vertical slide might allow some machining but at best the set-up would be flimsy and some designs have an inclined port face.

A number of ideas were examined including using the milling machine but this was rejected on the grounds of insecure holding and lack of faith in my ability to produce a good bore finish by hand-feeding the table.

Were the curved surface absent then a locating surface could be machined upon the base of the blank to a dimension of 2 $\frac{1}{2}$ in. from the bore centre and machining could proceed at one setting.

Splitting the castings

Thus there was only one solution, to remove the curved flange and to machine block and flange as separate entities, rejoining later (see photo 1). Patterns were made by a colleague, incorporating bolting lugs so placed as to match the tee slots on lathe and shaper. Ample metal was allowed for machining to give a good porosity-free surface and battle commenced by gripping in my largest machine vice fixed to the shaper table. Even the vice required modification by substitution of the moving jaw by a steel bar. For those without the luxury of a shaper, formation of these large flat surfaces can be achieved using flycutting methods.

Cleaning castings

Prior to machining cast metal the usual advice, and sound it is, is to remove sand and scale using old files, but in this day and age, the use of an angle grinder may be preferred and this I used. It is especially useful to remove the hard ridges where corners tend to chill in the mould and harden. Absence of this metal is kinder to the tool, machine, and one's temper.

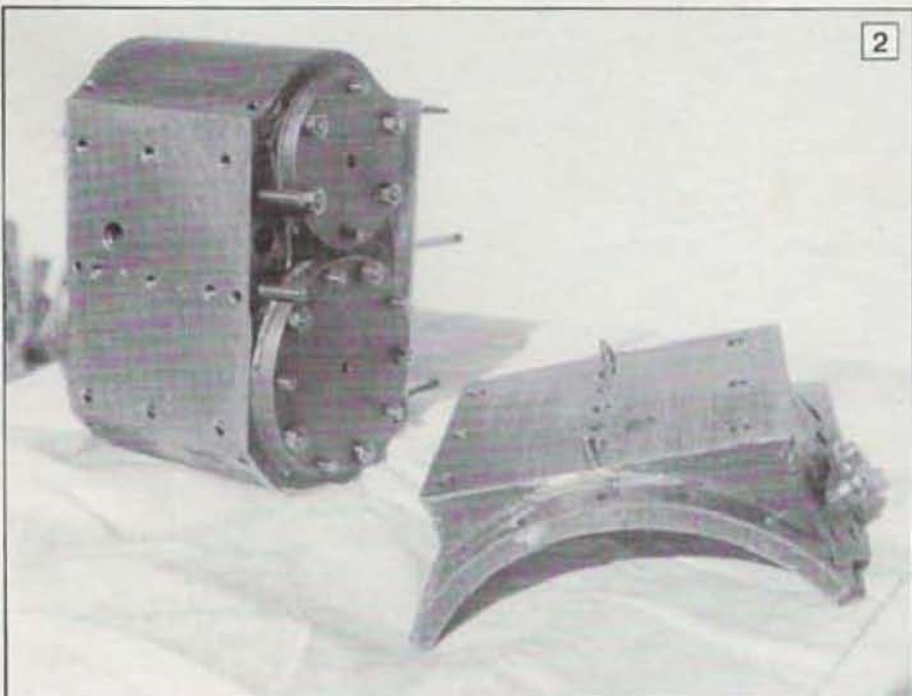
Obviously, a shaper subjects the tool to intermittent blows at cut commencement but so far I have suffered no disasters from this cause. Incidentally, I make my own 'special' tipped tools by silver soldering a 'used' commercial tip to a mild steel blank, subsequently grinding to shape.

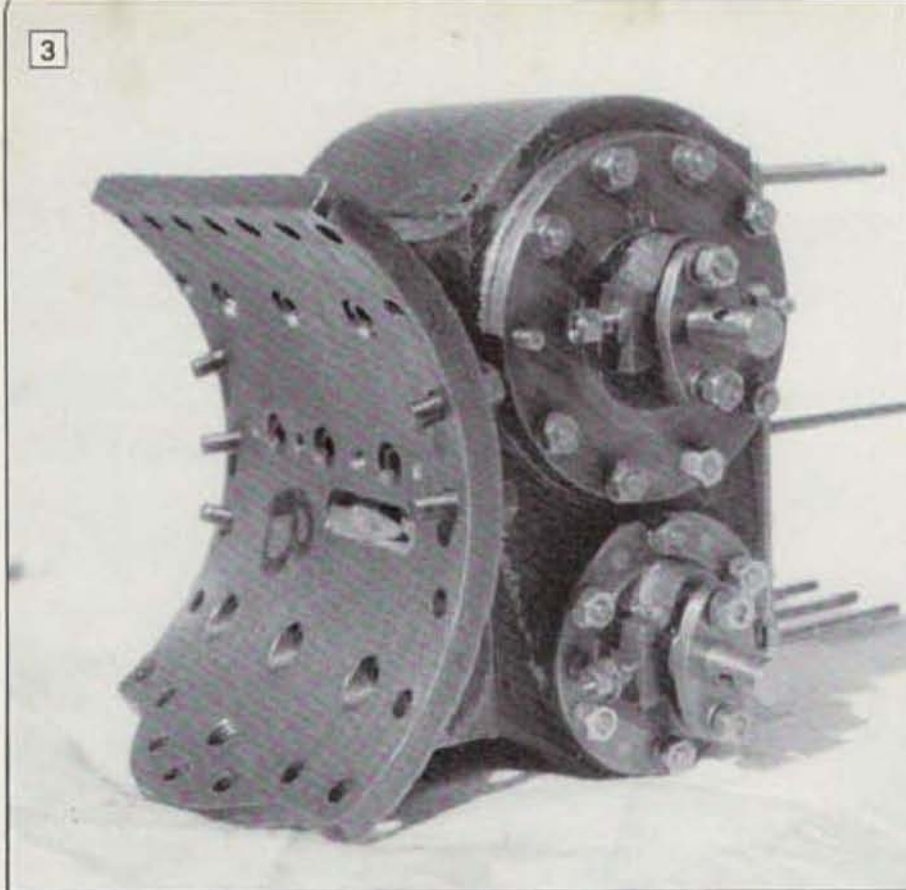
After the first pass, examination showed that thin areas such as the lugs were hard on the edges and this was removed. When soft metal was exposed, a high speed tool was substituted to ensure a reasonable finish and flat surface. Failure to remove the hard spots will result in excessive tool wear and an uneven surface, as testing with a rule will quickly show. This is undesirable and must be guarded against.

The curved flange, flat surface was similarly dealt with. Holding of these wide castings can pose a serious problem depending upon individual equipment and resort to ingenuity will often have to be made.

Boring the cylinder

Once a good surface to the desired size has been produced, the cylinder block is transferred to the lathe cross slide. As the bolting lugs are tailor-made, setting up is easy, requiring only normal precautions to ensure unmachined areas are squared up to best advantage. Boring was carried out using a 1 in. diameter boring bar with a





tipped cutter. I do not seek a superfine finish to bores, striving for equal diameter throughout the length.

My belief is that with metallic piston rings tooling marks remaining from a fine feed are conducive to oil retention and bedding-in during initial running.

Where two bores are called for, it is an easy matter to move the casting the required amount using whatever index the cross slide possesses or even a good rule. At the same setting, bore and faces were machined to length ensuring squareness. Naturally, normal machining precautions need to be taken, locking of slides, appropriate tool shapes, speeds and feeds and so on.

The cylinder flange

Coming to the curved flange portion, a flycutter of correct diameter was made to fit the milling machine mandrel and with the casting held in the (modified) machine vice the casting was hand fed through the cut. As anticipated, finish was not all that good but adequate for the purpose. This surface could have been machined in the lathe by fastening to a plate extending from an angle plate bolted to the table. Boiler centre would have been made coincident with lathe centre and the flycutter used. I rejected this method due to the flimsy nature of the set-up and because I was unsure at this stage where future bolt holes could go. **Photo 2** shows the machined interface at this stage.

QUICK TIP!

The modern plastic clothes line is filled with fine plastic hair. When a clothes line is broken and of no further use, cut a short length away from the end and you have a perfect little stiff brush that is ideal for cleaning the scrolls of chucks!

At the same setting the flange was faced to length ensuring squareness to the curve giving good appearance and a datum face. Now being the possessor of two halves of a cylinder casting nicely machined as accurately as skills and equipment permit, there now remained the task of joining.

Joining the cylinder parts

My method was to first machine the pistons to a good fit to the bores. I was happy to reduce diameters to running clearance later. A steel bar of the diameter matching the between web dimension of the cranks, in my case 0.5 in., was truly set and the roughed-out pistons mounted upon a machined nutted spigot for finishing. The length of the bar was made such as to allow for half crank pin diameter plus stroke so that when the crank pin was on back dead centre the piston face was flush with the bore end face, thus acting as a dummy connecting rod.

The curved flange had been drilled around the edge to match corresponding tapped holes in the boiler shell and was fastened thereto. Great care was exercised to ensure centre lines and distances were as per drawing. Centre lines on the castings were marked whilst *in situ* for machining which provides a check upon any inadvertent deviation.

Quick setting Epoxy resin was very thinly spread upon the flat surface of the flange and the cylinder block placed upon it

with the dummy connecting rod inserted within the bore and between crank webs with the end butting against the crank pins.

Given a modicum of care (and a trial run) this method ensures that the cylinder block is correctly positioned in relation to the crankshaft and boiler centre line. Once the Epoxy had set, $\frac{1}{8}$ in. dowel pins were fitted and the joint broken to provide a locating face for milling port faces, the drilling of various holes and so forth. Finally, 2 B.A. socket head screws were inserted to miss all these holes and the lugs removed. It ends up as a very busy casting (see photo 3).

Checking the fit

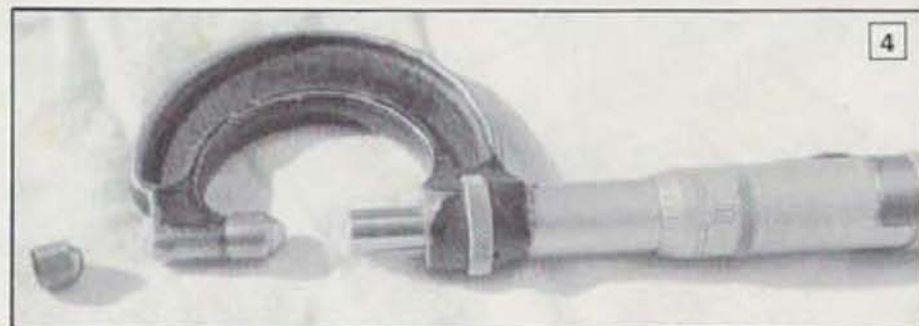
The engine has been trial erected and run on air pressure with entire satisfaction. That which should be square is square and all is in line as per drawing. Perhaps a few words as to the practical aspects of checking your results may not come amiss, together with a few hints as to the practical aspects of line boring. For bore measurement a variety of options are available depending upon individual resources. Vernier calliper inside jaws give good results if used with a little care to ensure that the instrument is held square to the bore and that a delicate touch is used. If one is brave, the pistons may be machined first and the bore machined to fit, the time me honoured go/no go premachined plug gauge is probably more practical.

More sophisticated is the use of internal callipers. They have the advantage that the boring bar may be left in place for measurement. Even more up-market are telescopic gauges, internal micrometers and the like. Owners or users of such things will be familiar with their use.

In a separate category is the use of $\frac{1}{8}$ in. diameter rod machined at each end to a blunt point for a length corresponding to whatever diameter is required and set across the bore, a number of these may be economically prepared to give warning of an approach to final diameter. They are also very sensitive in testing for a true diameter throughout the length of the bore.

Taking initial measurements

A little craftiness pays when setting the work upon the table to allow access for measuring, half the battle is to be able to measure. Splitting imposes two accurate measurements: bore to bolting surface; and, bolting surface to flange surface at the boiler centre line. Scrutiny of the drawing will suggest the best, possibly only, place for the split. In the case of the *Superba* block for instance, one would suggest just below the cylinder drain cock holes. Pre-calculate the dimensions and before machining ensure that it is possible to measure, and accuracy is assured. The bore/joint distance should be automatic at whatever your lathe dimension is, but



calculate and check early on, if an error has been made, now is the time to find out; and remember, the Epoxy must be thinly spread.

Another penalty of using the split method is the need to measure from curved surfaces, especially the boiler seating. Vernier callipers are very useful and also recommended is a ball (from a bearing) of known diameter (mine are 0.25 in.) held to the anvil of your micrometer with a homemade sleeve (see photo 4). This allows accurate measurement of curved surfaces, the ball is placed upon the inside of the curve and the ball diameter subtracted from the reading.

It should be noted that the use of a liner as per *Superba's* low pressure cylinder does not absolve the builder from the requirement of a true bore — not if the liner is to be a correct press fit: the annulus is not of critical dimensions and could be machined using a boring head or a stout bar in the four jaw chuck after all other operations are complete. It is a hefty chop in a small lathe and softly, softly catchee this monkey.

A special boring bar

One of the most important bore machining operations has been skipped, that of putting on the cut. A 1 in. diameter boring bar was mentioned because it is strong and I have a homemade device which clamps a redundant micrometer thimble to the bar over the tool (see photo 5). Increments are made by setting the thimble and gently moving the tool into contact. Care and feel are needed, what you planned to put on the tool may not necessarily be what comes out of the bore. Equally effective is the use of an inclined

hole in the bar with a grub screw to move the tool bit. The increment may be measured by micrometer or vernier and the same care is needed. Boring heads, if stout, are a good tool, but even so, a few surprises may ensue.

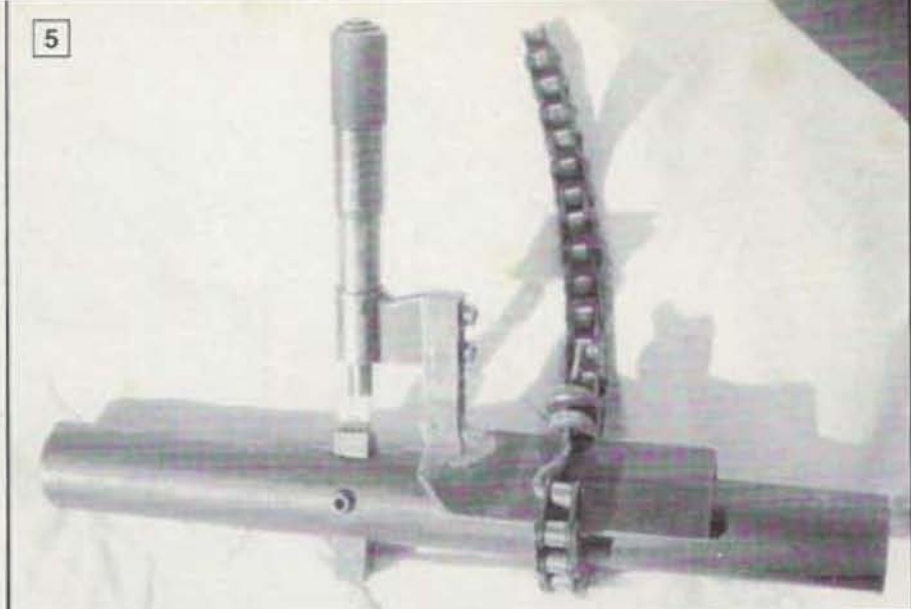
Finally, there is the "feels like ten thou" method which can be surprisingly effective. Usually the exact diameter is not critical, you can always make new pistons if that was your choice. Aim for a true bore — all else follows.

Conclusion

To conclude, whilst there is more work and an extra joint is involved there are advantages, not least that a larger cylinder block may be made than could be tackled

otherwise. The system of lining up with the crank webs ensures that any minor errors in machining may be cancelled out and second operations are assisted by the provision of the flat surfaces. Bolting lugs may be removed as late as possible and until then are of great use.

Upon reflection, it is difficult not to arrive at the conclusion that it is possible to be more accurate in the final analysis by using this method rather than by machining the casting as a whole. If machined using the faceplate, one would expect some sort of fixture to be required to locate the various centres and to space the curved flange and one wonders if a four jaw chuck would be a proposition. Possibly one of our other experienced readers would care to comment.



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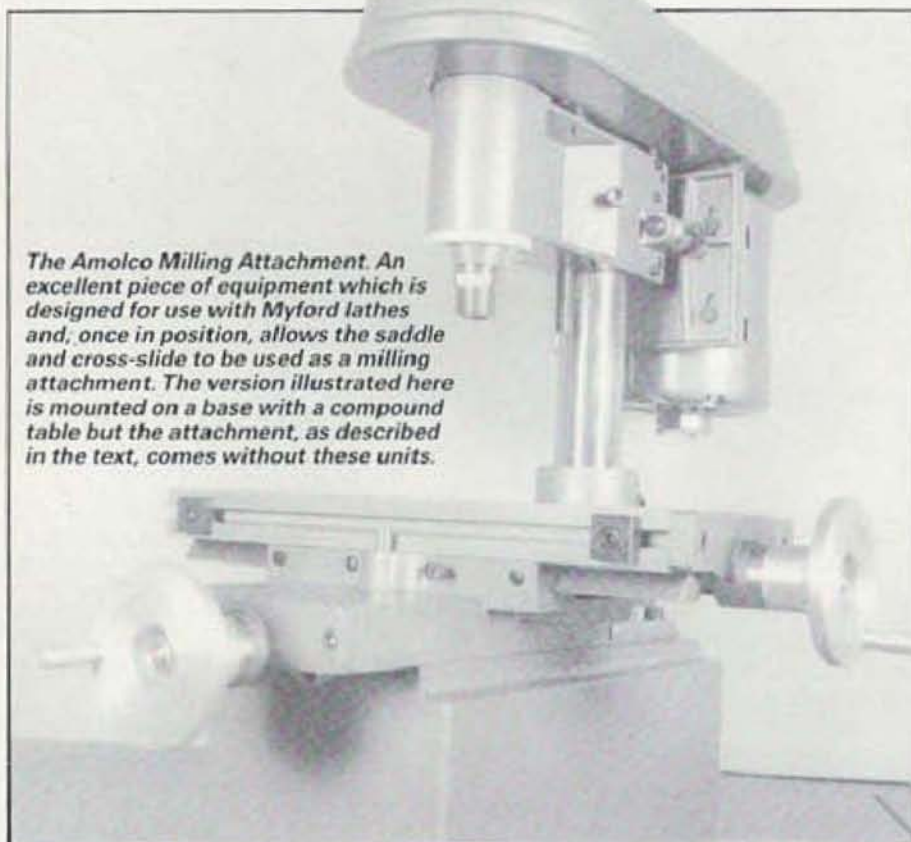
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A CRADLE FOR THE

A T T A C

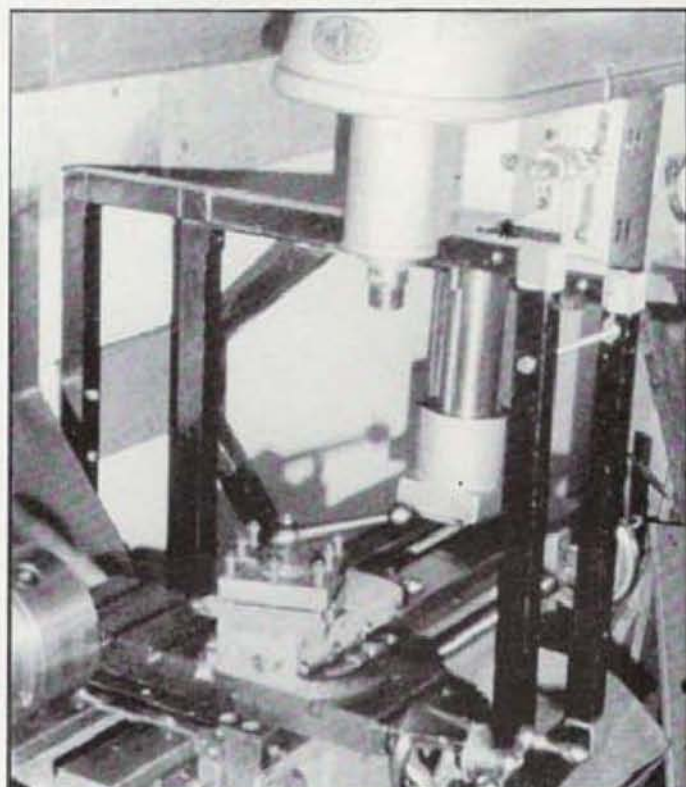
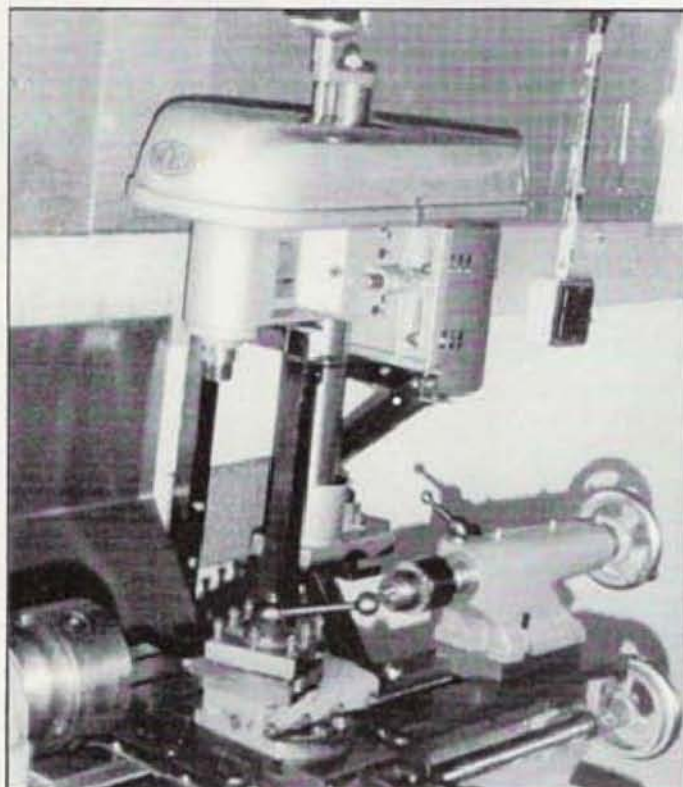
The Amolco Milling Attachment. An excellent piece of equipment which is designed for use with Myford lathes and, once in position, allows the saddle and cross-slide to be used as a milling attachment. The version illustrated here is mounted on a base with a compound table but the attachment, as described in the text, comes without these units.



When room is at a premium, the answer for milling, if one wishes to get away from the vertical slide, is to buy a milling attachment which bolts to the lathe and uses the cross slide as a milling table. They are very effective, and the Amolco attachment designed for the Myford lathe is a robust affair. K. Spreadborough tells us how he coped with his.

With no spare space in the workshop and a shortage of cash, a milling machine was never going to be a possibility for me! I decided

Below left, author's milling attachment and loading cradle seen 'parked' against the wall to allow space for turning operations. Below, to load the attachment, the cradle is swung across the lathe bed. No heavy lifting is involved. Below right, the attachment is lined up over the lathe bed then lowered and bolted into position on the bed. Far right, once the attachment is bolted accurately in place, the cradle can be swung back again out of the way while milling operations are carried out.



AMOLCO MILLING

H M E N T

therefore to invest in a milling attachment where the column bolts to the lathe bed. After some consideration I decided on the Amolco.

When it arrived I realised that the advantage of having such a robust attachment was slightly offset by the difficulty that was going to be involved in fitting it on and taking it off. Leaving it on is a possibility but it does clutter things up and make normal lathe work rather

awkward, when in fact the attachment will only be in use for a comparatively small period of time.

The space problem

Being short of space (and in stature, as well as long in years!) I realised that I had a problem, although I was very pleased with the attachment and looked forward to using it. Even if I could manhandle it into position when needed I had nowhere to keep it when it was not in use.

Most people who use Myford lathes will be only too aware of the space at the back of the lathe caused by the motor overhang — in my case, up to a wall behind the lathe. This then was where to keep it, but how to get there was the problem. On went the thinking cap.

Using some 1 in. square Speedframe and fittings (of course, if welding or brazing facilities are available any 1 in. square steel tubing will do) I built the structure as shown and bolted it to lathe cabinet stand.

The milling attachment is supported under the head, which is a heavy casting and also contains the motor, which adds to the weight. The support is made from eighteen gauge sheet steel which is screwed to the side of one rail or tube. It fits between the assembly plate and motor body and also locates the assembly laterally.

To protect the attachment from damage,

strips of adhesive tape are stuck to the assembly. The milling attachment sits quite happily on the support out of the way, protected when not in use by a plastic bag. It does not, in any way, interfere with normal lathe operations.

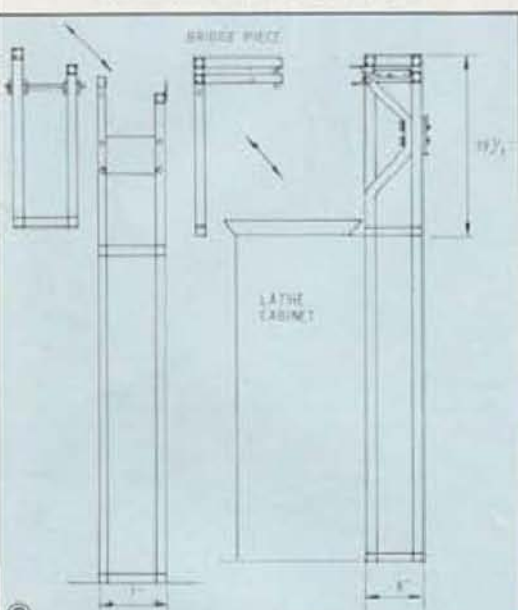
In use

The detachable bridge piece shown on the drawings is used to slide the attachment over the lathe bed when it is required. The column or pillar is lowered by simply winding it down the attachment, using its own fitted lead screw. Once in position the head can be raised to allow the bridge to be removed, and the attachment is ready for use.

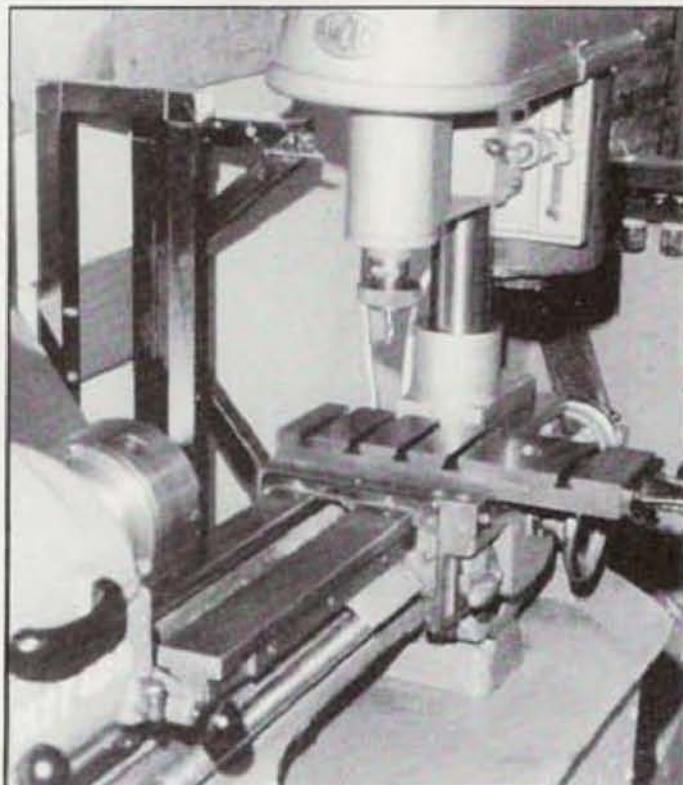
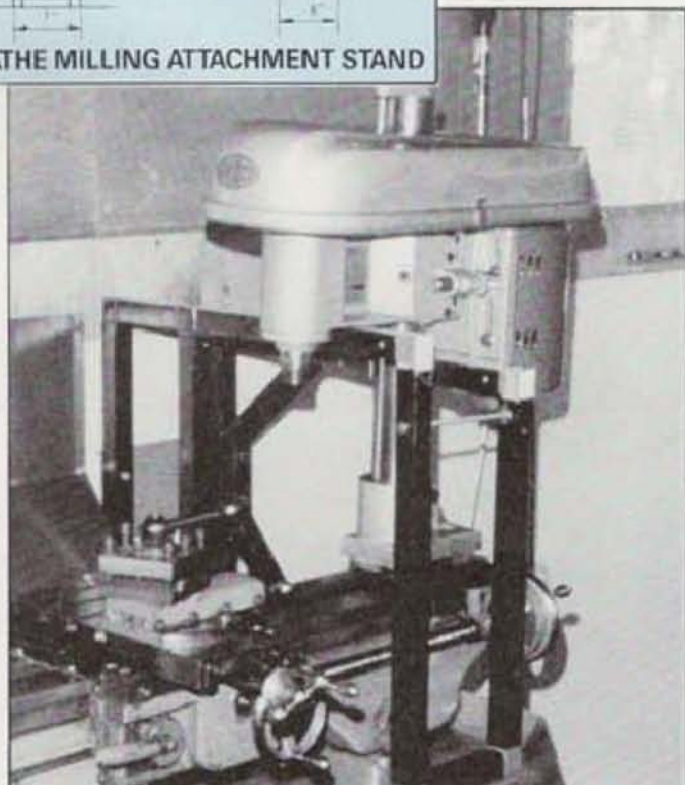
One further modification was made later; that was to secure the nut on the top of the pillar to the threaded rod which goes through it to clamp the attachment in position. Securing the nut made this an easier operation.

If there is a problem at all then it is in positioning the clamp plates under the lathe bed, which can be fiddly — a future project is to make longer plates which will make life a little bit easier. But there never seems to be quite enough time to do all the things I would like...

The equipment can now be put into place and removed in no time at all. There is absolutely no effort involved and, when not in use, it is stored out of the way.



LATHE MILLING ATTACHMENT STAND





THE HOBBYMAT V A R I A N T

Although we intend this magazine as a help to model engineers in their workshops, our scope will be wide and from time to time we'll include some woodworking items, particularly those involving machinery. In this article, Peter Jones takes a thorough and critical look at the Hobbymat Variant Wood Lathe, and a somewhat light-hearted look at woodworking.

We who engage in open metalwork have a somewhat jaundiced view of wood turning. There are visions of a massive machine, costing good money, burying the operator up to his ears in clouds of shavings and dust. He seems obsessed with turning out endless bowls and egg cups in exotic woods, whereas he could probably buy them cheaply. Yes, I know it's unfair, but this gives a flavour of the paranoia.

But then, out of the blue, we come across the need to turn something ourselves. The usual approach is to treat the timber as a piece of honorary metal and worry it into shape with a carbide tipped tool and wonder at the blanket of dust which has settled on our precision machinery and projects.

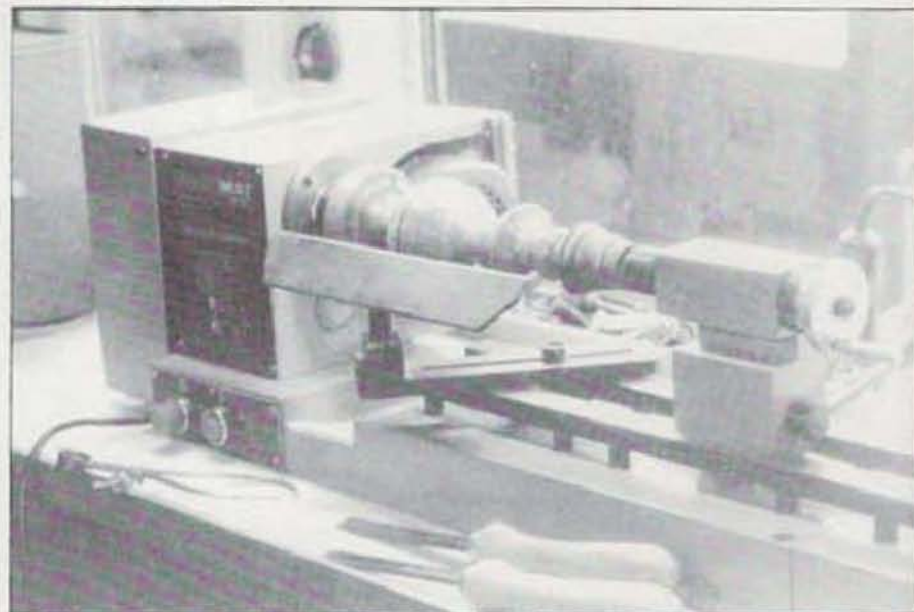
Fortunately for us, Präzima Limbach, the manufacturers of the Hobbymat seem to have met our needs exactly. They have taken their engineering technology and produced a machine with several attractive features. The first of these is price. Recommended retail price is £199 + VAT (although shopping around may reduce this a touch). This seems to make it an achievable target that can be justified by the sort of work we can put it to.

A perfect fit

From time to time I get to use various machines. Many are quite good but are so big as to make the sky grow dark. At the other end of the scale is the tiny miniature

lathe which struggles to sharpen a pencil. The Variant fits the model engineer's workshop quite nicely. It has a 2-piece bed and most jobs can be tackled on it in its shortened form. This calls for a bench space of approximately 2ft. 10in. x 14 in. For large jobs, the extension bed brings the length up to around 4 feet.

The Hobbymat Variant in use; a finial for a signal on a miniature railway being turned between centres.



I confess to dubious practice when asked to turn a decorative top on a 6ft. flagpole (don't ask...) I pinned the extension bed down on to the bench, some distance away from the rest of the machine. This unusual approach was very successful. In practice I leave the lathe permanently set up, complete with the extension piece; I can spare the space.

As is usual with this manufacturer, the machine comes complete with many extras as standard, including a set of 6 chisels. The one extra I would advise purchase of is the 5in. woodworking chuck. This speeds up many jobs considerably.

Dry technical data gives no feel for the bulk of the machine. It weighs just under

THE HOBBYMAT V A R I A N T

70lbs and will turn out a cannon barrel some 26in. long x 9in. diameter. Because of the cutaway in the bed, it can also manage a disc of about 11in. diameter. The motor is 370W and provides a suitable amount of power for the machine. Three speeds are available and change is effected by some fiddling around inside the casing, with belts. This is not quick, and operators tend

eye open for more, at car boot sales and the like. This isn't the place to give a treatise on wood turning, but the simple techniques come easily enough to a model engineer who is alive to the feel of material changing shape under his hands. You may not be able to produce a perfect sweep of the chisel at first, but fortunately there is an easy way out.

pine. You will become a horder of old table legs.

Once you have a wood turning lathe you will find regular employment for it. Over and above decent, proper, model engineering tasks, there will doubtless be a variety of domestic uses, together with a desire to tackle wider forms of craft modelling. Whatever you do, you will generate shavings. These are easier to clean up than dust, however.

My *modus operandi* is to have a wood turning session once a week. I put up a cardboard screen behind the lathe and this keeps the mess down to a minimum. When I have finished, I run the vacuum cleaner round and give the workshop a brief tidy up. This routine seems to work for me.

In conclusion, I have found the Variant to be a valuable and worthwhile addition to the workshop. I was a bit sceptical that I could justify the cost, but such fears were groundless. I commend it to your consideration without reserve.



Variant MD 120 showing extension bed and tool rest fitted.

to stick to a comfortable speed. It isn't good practice, merely a fact of life.

Hidden extras

The other hidden extra you get is the rediscovery of turning wood properly, with the right tools. The set that comes with the Variant tackles most of the basic jobs, although you will inevitably start to keep an

Here, a pattern for a buffer stop is machined in the four-jaw chuck.

A sharp tool at the right angle FEELS right. The chips fly off and the wood sculpts easily – particularly if you are using a piece of close-grained hardwood. When something like the right shape is approached, you can remove the last whiskers with progressively finer sandpaper, ending with a final polish of wirewool as the job spins. (You will get used to the unnerving experience of having your hands close to revolving work.)

The use of sandpaper is considered not quite cricket by some wood turning instructors, but it will get us by for now. If you want to burnish the wood further, the application of a piece of dowel to the spinning surface will close the grain tightly. For a nice natural wood finish there are all sorts of old recipes. For general purposes I finish off with a drop of linseed oil and some Beeswax. You will become interested in the beauty of nice turned wood and will investigate the use of Carnuba Wax and similar substances. For general use there is a marvellous product by Coronet called "Speedaneze". It is just the right mixture of substances. You apply it with a cloth to the spinning job and the heat produces an instant rich, deep finish.

You will become more aware of the properties of different woods and be in danger of becoming lyrical over a nice piece of Holly. But much of what we want to do will call for humbler material. For patternmaking, pieces of ply glued together form a stable workpiece. Convenience will dictate that various jobs will use ordinary

SPECIFICATION

Centre width:	300mm +350mm
Centre Height:	120mm
Turning dia. in gap:	300mm
Headstock thread:	M30 x1.5
Tailstock:	Fitted running centre
Speeds:	950, 1450, 2100 rpm
Motor:	370W 240V
Weight:	30Kg

Supplied as standard

Set of 6 chisels
driving centre
tool rest
faceplate + woodscrew centre
egg cup chuck
Extension piece for bed as described
Tool kit

Optional extras:

125mm self-centring woodwork chuck.
Reversible jaws (or may be used as a faceplate).

Includes: driving dog, fixed centre, woodscrew centre, tool kit.

Price: Standard Lathe: £195 +VAT
Chuck: £39 +VAT.

Obtainable from suppliers of Hobbymat/Prazimat etc.

Further details from: C.Z. Scientific Instruments Ltd, 2 Elstree Way, Borehamwood, Herts. WD6 1NH. Tel: 081 953 1688.

A M I N I WORKSHOP

Les May, whose workshop this article features, has promised to provide us with regular contributions to the magazine in the future, novel ideas which will be of interest to readers. His motto seems to be that nothing is impossible if given a little thought. His engineering background is extensive; a technical education at Borough Polytechnic was followed by a lifetime in many facets of engineering. A toolroom apprenticeship led him to extensive employment in the sheet metal field with all the operations involved. He then undertook precision instrument work, jewellery-making and then became works manager at Johnson Matthey Ltd, where his work involved civil engineering as well as heavy mechanical work. His vast store of knowledge will, we hope, be put forward for us to use...

Getting a camera into the tiny workshop of Les May was like a conjuring trick! The small wooden shed, about eight feet by six, is packed with machinery and equipment. It contains two lathes, a shaping machine, a horizontal/vertical milling machine, and a homemade bench drill, plus a bench with a vice for handwork.

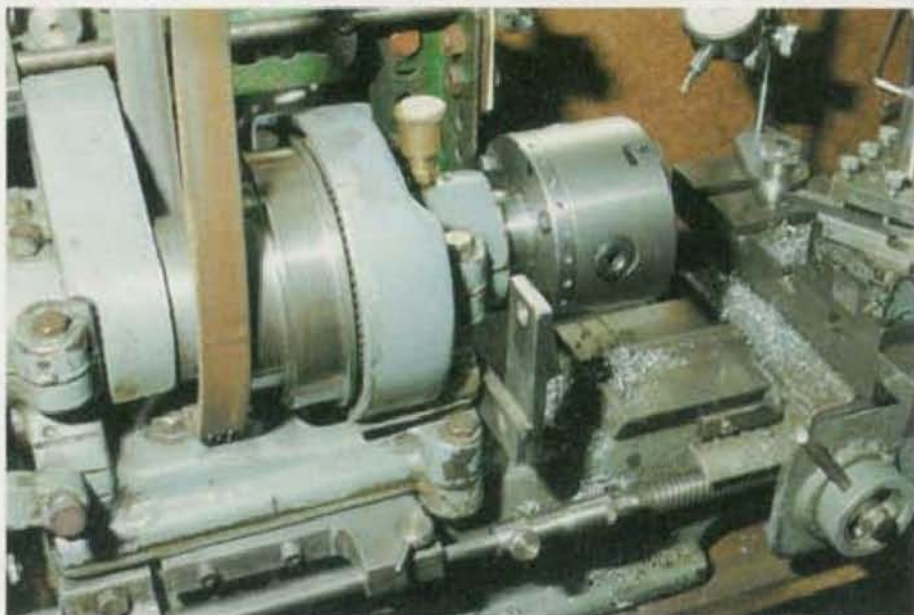
The owner makes virtually everything

he needs and the abundance of small equipment reflects this. Special tools for special jobs are around in abundance, and these reflect the expertise of the owner. Small tools are made from carbon steel which he finds quite adequate for normal work and amongst the many homemade milling cutters was one no more than 1/32in. diameter.

Simple fixtures make light work of many tasks and work holding is no problem with a whole range of small machine vices, all of which are, of course, homemade. The workshop is not a pretty place, kept spotlessly clean; it is, however, tidy enough for the owner to know where everything is

and to be able to find it with no effort at all — and it's quite cosy. Now retired, Les spends all his spare time in the workshop, mainly, it would seem, helping others; although in the past as well as making many tools and fittings he has constructed locomotives and stationary engines.

The visit proved to be an education in how to make something that will do the job that is at present to hand and we look forward to his future articles with great interest.



Typical of the many simple ideas with which the workshop abounds is this holder for a dial test indicator to bolt to the lathe cross-slide. Such a practical idea yet one rarely seen. Les has promised details of many of his small tools and gadgets for future issues. Centre right, all this equipment and there's still space to work! Although much of Les' machinery is very old, precision is the keyword in all of his work — which goes to show that, in the long run, expertise counts far more than expensive, fancy equipment. Bottom, the ancient and well-used Zyto lathe. It is fitted with a micrometer adjustable stop that can be seen in the front of the bed. The chuck backplate is drilled for indexing and the 'L' shaped pillar holds the detent. Another indexing system works from the change wheels making an almost infinite number of divisions available if required, and all without resorting to expensive dividing heads.

S O F T

SOLDERING

Good soldering techniques are useful for many tasks that the model engineer, model maker, or handyman has to perform. This is an in-depth survey of what is involved, and some of the materials and tools that can be used.

This is the first of a series of articles dealing with the joining of metals by means of heat. The techniques described will get more advanced as the articles progress. However, any means of heat jointing requires similar application for the best results.

We deal with soft soldering first, this being the most common of the various methods as well as the one requiring the least heat. I am quite sure most readers will have soldered various items from time to time, some with success, others may not have been so lucky. Soldering is an unusual business as, frequently, we can look at the finished result and believe it to be a job well done only to find that as soon as the item is taken into use the joint breaks down!

Irons

Let us first of all look at the tools which we will use. When I did my engineering training we were always encouraged to make for ourselves several different soldering irons. These were of differing

To test if an iron is at the correct heat, apply solder. It should flash to liquid state rather than dissolving slowly.



Typical selection of soldering irons. The small one at the bottom is ideal for wiring work while the 60 Watt model in the middle is good for general use. The large 120 Watt model at top is capable of dealing with very large work but takes much longer to reach operating temperature.

sizes since it depends on the work to be carried out what size of iron will be needed. Of course, the irons we made were heated on a gas ring or in the flame of a bunsen burner — nowadays most people rely on the electric soldering iron, and strangely enough this could well be one of the reasons that joints may fail. Later we will come to the reason for these failures

Although electric soldering irons are cheaply and easily available, the old-fashioned copper iron can still be the best tool for some types of work. It is doubtful if many places now stock these although I am quite sure they are still in frequent use.

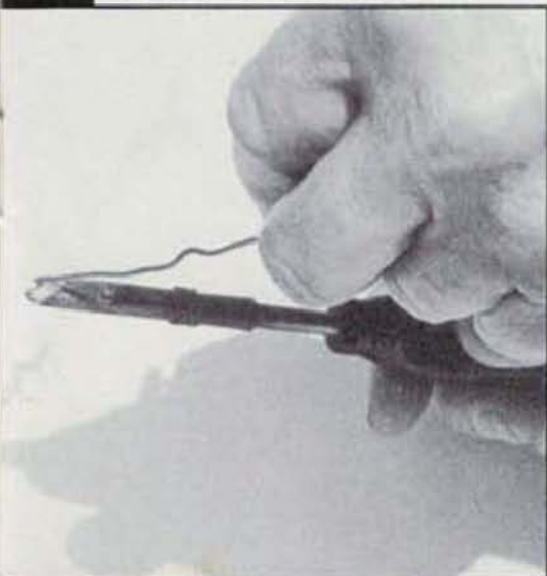
We can easily make such an iron. All that is needed is a decent chunk of copper bar, either round or square. This is drilled and tapped a suitable size for the rod that connects it with the handle. The rod itself is simply a piece of mild steel of suitable diameter threaded to enter the copper bar, and with a flattened point filed on the other end. This flattened end is fixed firmly in a wooden handle of the type used on a file. All sizes are entirely a matter for the individual and largely commonsense. Obviously the rod must be thick enough to support the copper bar so that there is no whip, and long enough to be manageable but also to keep the operator away from the immediate heat. Likewise, the handle should be a sensible size for the particular iron. It all sounds a bit vague but it really is a matter of commonsense.

The copper bar, or bit as it has now become, is filed to shape either before or after it is screwed to the rod. The shape again will depend to some extent on the work the iron is to do. In some cases a flat

wedge shape is best, in others a point. Pointed bits do wear away rather quicker than the chisel-shaped type. All irons, whether of the type described, or electric, will need the bit constantly dressed to shape. As the iron is used the point or wedge wears away and becomes pitted and this is why the dressing is needed. After an iron is filed to shape it should be heated and dipped in flux, preferably of the resin type, and then solder allowed to spread on it. When this covers the working part it should be brushed off while hot, leaving a nice smooth finish. Only when an iron is in this sort of condition will it work at its maximum efficiency. For brushing off solder a piece of thick felt is as good as anything but do not let it linger on the iron or it will stick to it. Just wipe it over very quickly.

Joints

Soft solders of any grade do not have great strength and it is essential that a sound joint is formed when soldering. To obtain this we must first of all look at the type of joint we are going to make. If it is wire that is being joined, there must be an overlap since it is not possible to get a good butt type of joint. This will also apply when metals of small section are being dealt with. With larger areas, a well-made butt joint can prove perfectly satisfactory. The rule is, the larger the area joined the greater the strength. If then we try to join two pieces of brass strip 1.5mm or $\frac{1}{16}$ in. thick and 6mm or $\frac{1}{4}$ in. wide, end-on, the joint will not be strong unless there is an overlap. If, however, our strips are the same thickness but, say, 25mm or 1 in. wide,





When soldering, the use of a simple jig is an advantage. A wooden one such as this allows joints to be made at 90 degrees with precision as long as the jig is accurately made.

there is no reason why we should not get a reasonable joint by butting, although it will still not be as good as one with an overlap.

If the metal to be joined is at a right-angle then there will not be as much strength as the overlap joint but there will be more than in the case of ordinary butting up. This is because a fillet of solder will be formed in the angled joint, which means a larger area of support. Whatever happens in a butt joint, a minute gap should be left between the items to be joined in order to obtain maximum strength. This allows the solder to seep in between the metals - without the gap it is possible that only one side of the metal will have the solder joined to it. In all such cases the work should be turned over ultimately to ensure that the solder has penetrated right through the joint: it is not always quite so easy to leave a tiny gap with a right angle joint but there must still be an examination to make sure that the solder has penetrated.

All joints should be supported whilst the solder is applied. Simple wooden jigs, or even holding the items together with wire or tacks, will do but it is essential they do not move during soldering or while the solder is cooling. If a great deal of soldering is planned it may be worthwhile making up a special form of clamp to hold work.

Applications

That, then, is the basis of good joint formation and strength. Now let us come to the various applications. If we are to do some wiring on electronic components then a very small iron will be needed. There are two reasons for this; firstly it will be more convenient in confined places, and secondly we do not want too much heat as this can damage the components. Nowadays most electronic components are wired via a copper sheet which is secured to plastic and has a series of grooves and possibly holes in it. This is a printed circuit board and too much heat can cause the copper to come away from the plastic. The copper really only acts as a joining wire, and years ago we would have joined all our components with individual wires. Now we can solder them to the copper and let that carry the current to the next one.

Assuming we will be using an electric iron, and in these cases such an iron is far more convenient than the gas type, then if there are to be long breaks between the

use of the iron, and it is to stay switched on during that time, a heat sink will be required. This sounds very technical but is only a piece of suitable metal that will disperse the heat from the iron when it is not in use. If an iron is allowed to overheat the point may become burned and the iron will need redressing and tinning before it is used.

For this sort of electrical work one of the cored solders is best, and if possible a very thin one. The larger diameter solders take more heat to melt and this is not good practice when dealing with fine joints. The correct types of solder and the various fluxes will be the subject of later paragraphs but apart from the solder itself the actual technique required will be the same as for all soldered joints.

When we require to solder two pieces of metal together we will almost certainly need a bigger iron than that used for electronic work. It will also be wise to use a separate flux rather than solder of the cored type. The work should be thoroughly cleaned along the edges where it is to be soldered and then covered with flux along the proposed joint. Each piece of metal should then be tinned, which involves running solder along the area. The solder must mate with the parent metal. After

tinning, the pieces can be brought together and refluxed. The solder can then be run along the joint.

It sounds very easy to do but there are many pitfalls. In all cases of soldering it is essential that the solder melts on the metal and not on the iron, although it can be placed very adjacent to the iron. This involves raising the temperature of the metal to a point where the solder will run freely upon it. The way to do this is to leave the iron in one position until solder will melt on the metal and then very slowly move it along. The metal should retain its heat as the iron travels slowly along.

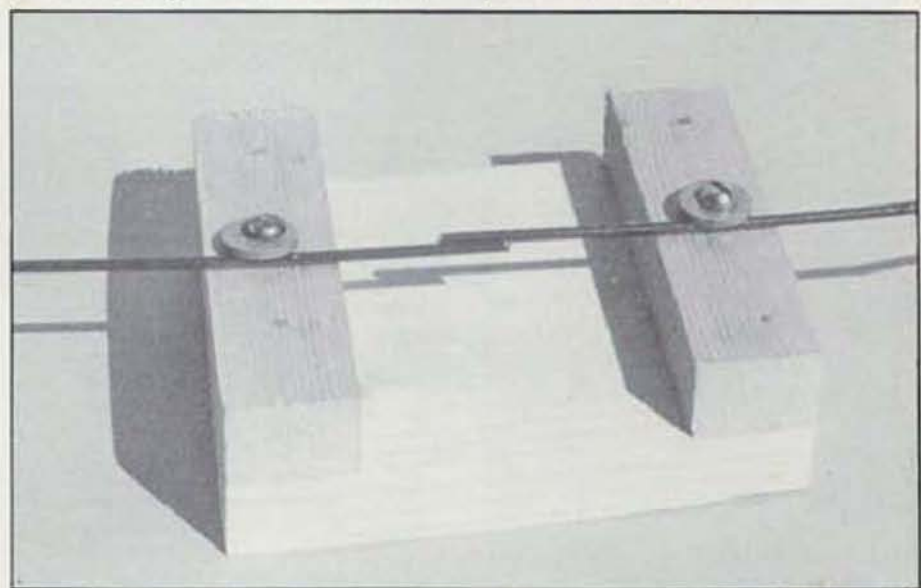
It follows that the iron must be big enough to transfer the heat and also hot enough in the first place. Many joints are spoiled because the operator will not be patient and let the iron reach full working temperature, and yet unless it does, the joint will be doomed to failure. We can easily see when the iron is hot enough, but equally the impatient person can just as easily be fooled into believing the iron is hot when it is not. As temperature is raised, smoke or fumes will be seen leaving the iron and it is at this point that the uninitiated will be fooled into thinking there is sufficient heat. Full heat will still be some time away after the initial smoking effect.

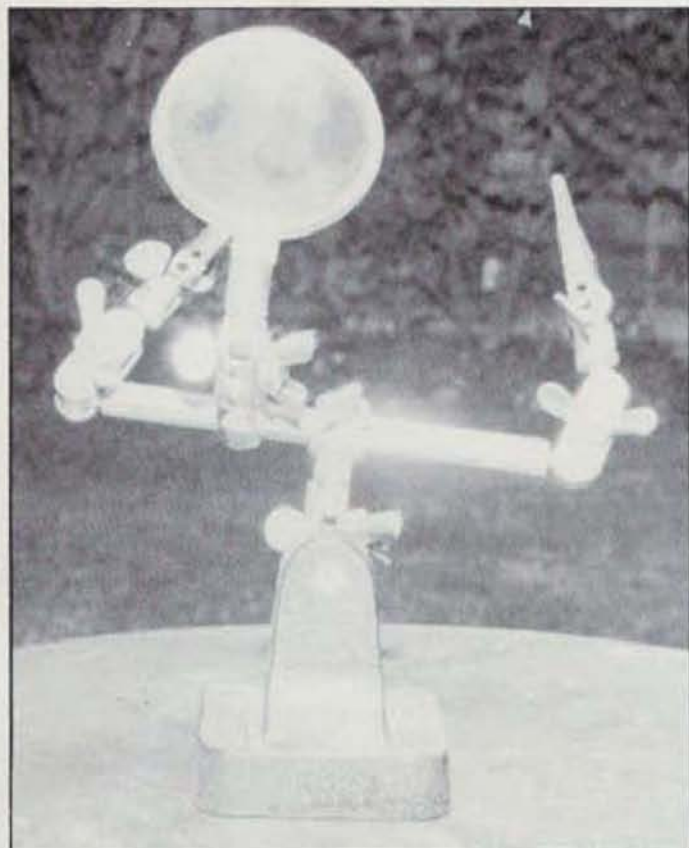
When the iron is believed to be hot enough it should be touched with the solder that is to be used. The end of this must literally flash away. It is no good it melting slowly; it really does have to just disappear. If this happens the iron is at the correct heat and the solder used for testing should be wiped away. The iron must then be left in contact with the work until the solder again runs quickly. If the running effect is slow then there is not sufficient temperature and attempting to make the joint will result in what is called a *dry joint*. This is a joint that looks perfectly sound but will break as soon as pressure is applied; such joints are almost entirely caused through not getting sufficient heat to the work.

Blowlamps

Sometimes no matter how large the soldering iron is it is unlikely to make an efficient joint because it will never be able

Another simple jig for wire or thin strip joining; you could also use this arrangement with a soldering torch since the work is held proud of the wood.





Sometimes seen advertised under the name 'Helping Hands', this useful device allows location and holding of work for soldering and other operations. The magnifying glass aids in the lining-up process making extremely intricate work possible.

to raise the temperature sufficiently. In those cases we need to use a blowlamp or torch to heat the work. There are various forms of blowlamp available but, as in the case of the iron, it is best if one suitable for the specific work can be obtained. The larger types of blowlamps sold in D-I-Y shops are not usually suitable for model making and although they can be used for plumbing work, etc., they are not as efficient as might be thought. Usually the flame is somewhat woolly and this means that the heat is spread rather more than we require.

There are blowlamps available that will give a nice neat flame and these are the best type to use. Propane will give a better heat than Butane and if a blowlamp is being purchased then the Propane one is the best type to get. The flame should have a nice cone shape and finish in a fine point, which can be directed to the work.

When a joint is made using a blowtorch it is as well to use the same principles as one would with an iron. The surfaces should be tinned first and then the joint made after complete tinning has been achieved. However, it is possible to make joints using blowlamps without prior tinning, if tinning is not a practical proposition. The reason we tin surfaces first is to ensure that the solder has thoroughly adhered to the parent metal and, while it is difficult for an iron to supply sufficient heat to cope with both pieces at once, a blowlamp may well be able to supply sufficient heat for both surfaces at the same time.

Actually, the main danger when using the blowlamp is that we will overheat the metal. This will degrade the solder and the

rule therefore must be gently to heat the metal until the solder reacts as it does on our iron. When that happens further heating must be kept to a minimum.

Only practice and experience will ensure perfect soldered joints although direct help from someone who knows what they are doing can help quite a bit, too! Mainly, constant practice is the thing, and when the art has been truly mastered soft solder joints that are really strong can be made.

Types of solder

So much for the technique, now how about the materials themselves? Soft solder comes in a whole variety of types. Originally each type was made for a specific purpose and if we were working in industry and could order several kinds of solder at a time then the manufacturers could make us a solder that was absolutely right for the purpose we had in mind. We are not in a position to do this, of course, and so we must use what is available. Here again availability depends on where one goes to buy the solder. It is absolutely no use whatever going to the large D-I-Y stores and asking the assistant for solder for a particular job. It is very doubtful indeed if such a person would have the faintest idea of the ability of the product. Some builder's merchants have a little more idea but not always does this apply. It is therefore essential that we learn what the solders are for, what their temperature range is and what metals they are best used on. The same will apply to fluxes.

The most common type of soft solder seen these days is the cored version. This is ideal for all small electrical work but not a lot of use for other purposes. It is, like most

The flame produced by a blowlamp of this type is usually too 'woolly' for modelling work as it spreads too far over the surface area of the work. However, there's a good choice of miniature Butane-powered torches available on the market which offer an intense and very controllable narrow flame.



soft solders, an alloy of tin, lead and antimony with a melting range between 183 degrees and 220 degrees Centigrade. The composition will vary from manufacturer to manufacturer but will probably be about one and a half parts tin to one part lead. The central core of flux is resin-based and is non-corrosive.

Tinmans Solder has a temperature range of from 183 degrees to 243 degrees Centigrade and is made of around one part tin and one part lead. It has greater strength than the cored solder and is useful for joints made with a blowlamp but will melt with a soldering iron.

Plumbers' solder has a composition of about one-part tin and two-parts lead; it has greater strength than either of the

QUICK TIP!

Many model engineers now have radio cassette/players in their workshops to make being there even more of a pleasure. Keep a spare tape and record on it up-to-date information as to how a particular project is going, readings on gauges that need referring to later, and where you stored that piece of work or equipment that, without some sort of reference, will not surface again for a number of years.



previous two solders and has a higher range, the melting point being around 243 degrees Centigrade. It is difficult to use with a soldering iron unless a particularly large one is in use. It is not easy to obtain nowadays but a modern equivalent is HT3 which has a range of 236 to 243 degrees Centigrade.

For those interested in jewellery-making a solder known at one time as Pewterer's Solder is the thing to use. It is made of one-part tin, one-part lead and two-parts bismuth and, as the name suggests, is particularly useful on pewter or silver, also giving a very good colour match. The

temperatures. As the first metal melts the solder achieves a semi-liquid state and this is known as the *solidus* and is the lower of the two temperatures. When the second metal melts the whole solder becomes very fluid and this is known as the *liquidus*, the higher of the two temperatures. It is essential that joints are made at the higher of these two temperatures.

Fluxes

Fluxes are used to enable us to make good joints; they are really only cleaning agents. As metal is heated it will oxidise

The popular Sievert range allows different sizes of nozzle to be fitted to the torch. There are several small ones which are highly suited to our purpose and give maximum efficiency. Any Sievert dealer will be able to supply details of suitable equipment and can also offer expert advice on the right nozzle to use.

and this oxide will prevent solder from adhering to the metal. The flux prevents this effect and so ensures a satisfactory joint. There are two main types of flux used for soldering – resin based ones such as 'Fluxite' or 'Frysol', and the acid type usually sold as 'Bakers Fluid' which is really killed spirit – hydrochloric acid with zinc dissolved in it until the action ceases.

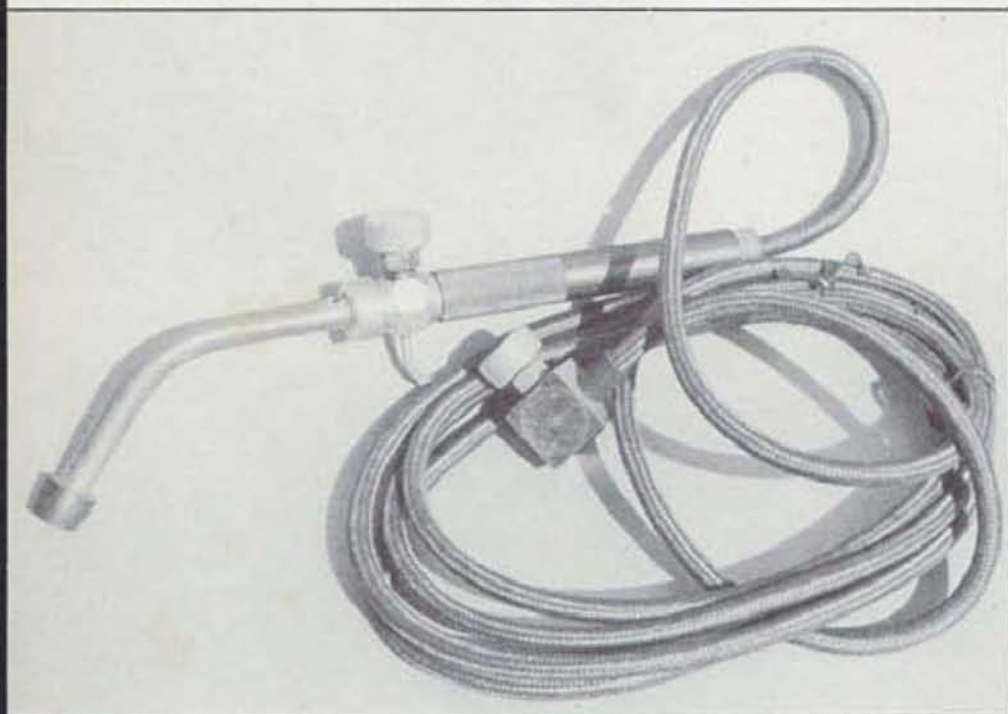
The spirit is best for joints on steel but is also quite satisfactory on copper and brass. All fluxes should be cleaned away after work has finished but particularly so with killed spirit which can be quite corrosive. It can be removed with water whilst the resin-based fluxes need to be washed away with methylated spirits or alcohol. There are a number of other fluxes used for special purposes and, whilst at one time the craftsman would make up his own flux, nowadays a whole variety is on sale under various brand names.

Soft solder can also be obtained in paint form which consists of finely powdered solder mixed with a flux and sold in jars. In practice, the joint is simply covered with the substance and heated until it melts. The system is very effective where some form of overlapping joint is concerned and it is also convenient and a clean method of working. However, it is not at all suitable for butt joints.

There is another range of soft solders which melt at much higher temperatures; these are usually silver bearing alloys and we'll deal with them next time.

This tiny gas torch carries its own supply of Butane and can be refilled from a cigarette lighter cylinder. Suitable for small work only but highly convenient.

This small torch, which connects up to a cylinder of camping Gaz, is designed specially for model work. This particular model is no longer available but you'll find current equivalents on sale from specialist suppliers.



melting range is around 200 degrees Centigrade which is well within the capacity of a soldering iron.

For readers who are wondering why two melting point temperatures are given, let me offer an explanation. We have established that solders are alloys of two or more metals. Both of these have differing melting points so when we heat our solder the two metals will melt at different



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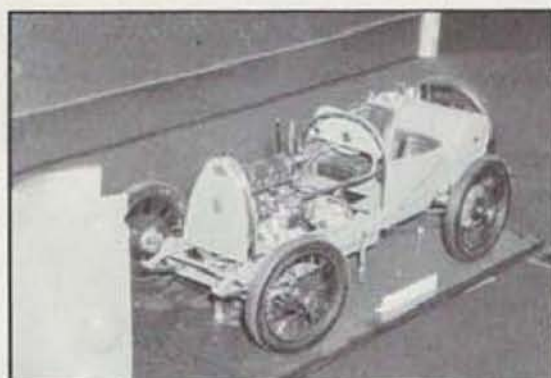
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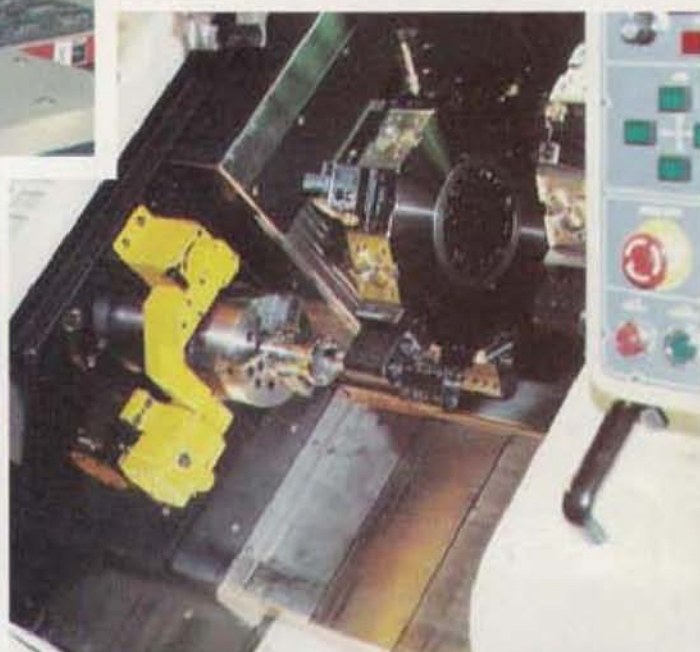
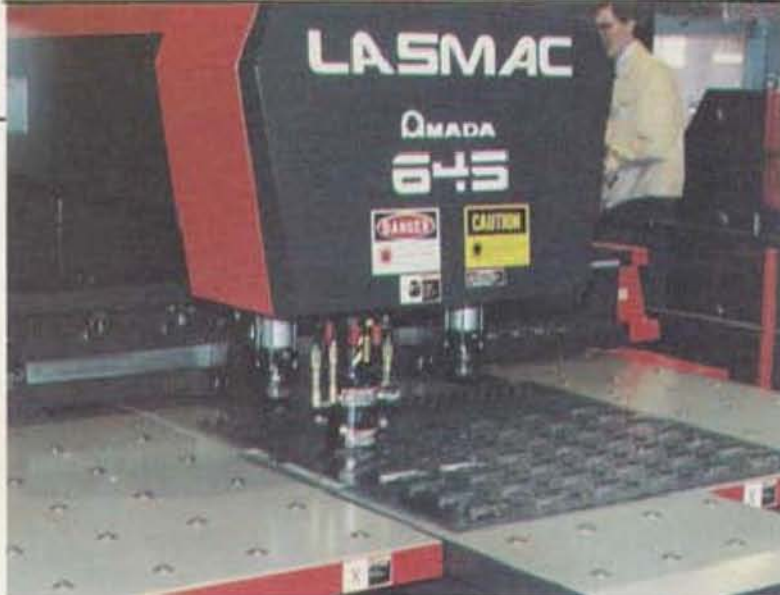
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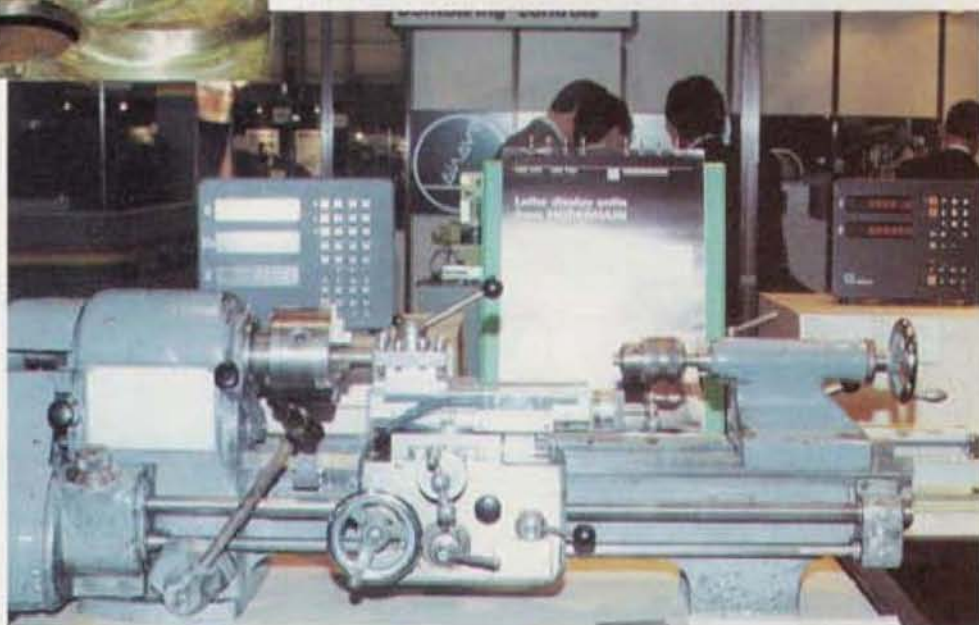
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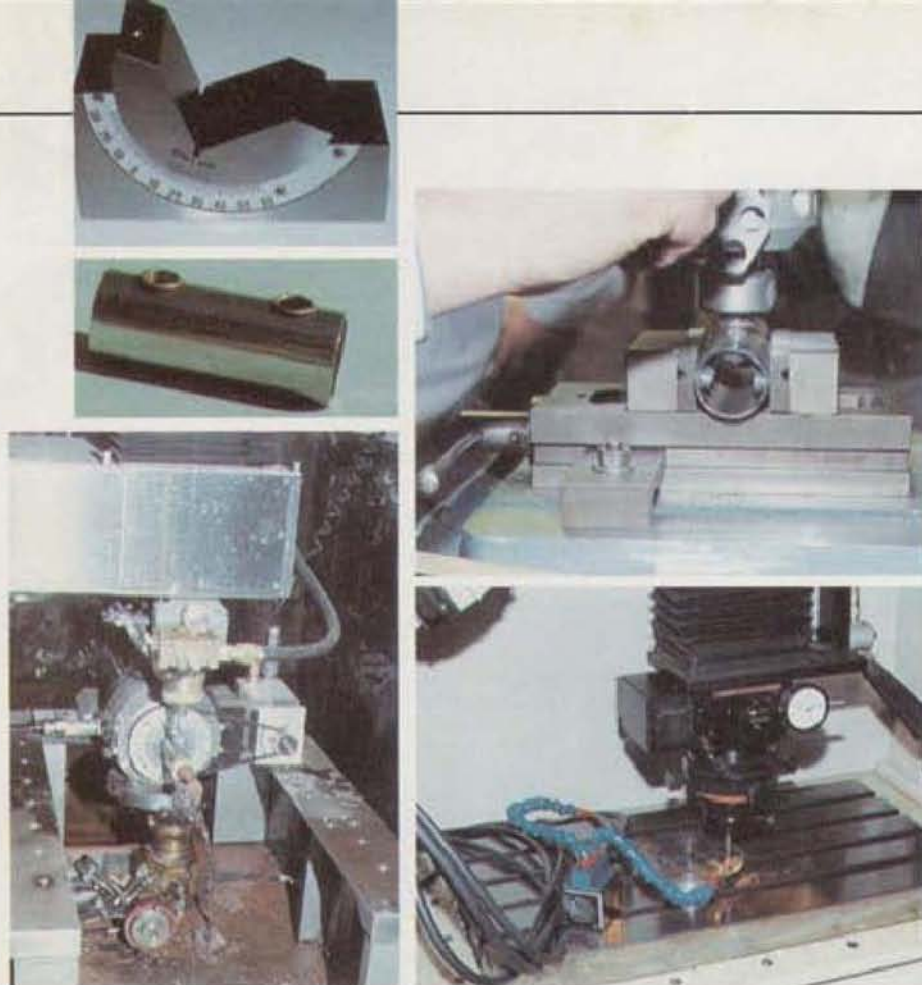
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Top left, laser cutting machines were much in evidence; rapid clean cutting of parts from sheet metal in quantity is their usual application but they can be useful for single items as well. Top right, an impressive example of laser cutting; tiny component, compared for size here with a twenty pence piece, is cleanly cut and requires no further machining. Above, something to be considered for the home workshop is a Seco belt sander, like this hand-held machine. Will take belts from 1 in. wide upwards and will get into the tightest of corners making it ideal for cleaning castings and finishing off welded work. Above right, fully computer controlled machines such as this lathe seem to have no direct application in the home workshop – at the moment, at least... At right, digital read-outs on machines could be useful at home and this is something we hope to consider in future issues. Photograph shows a very old lathe fitted with three sensors (one on each movement) giving a reading on the screen at the back. Apart from the ease with which the travel can be read, big advantage is the fact that only the travel shows on the read-out so backlash is no longer a problem.



ENGINEERING OF THE FUTURE



Top left, Linear Tools had a range of small items which could be of use in the home workshop, particularly useful was a range of these swivelling vee blocks. Top right, called 'flow-drilling', this tool fits into an ordinary drilling machine and raises a bush at the same time as it burns through the metal. Centre left, an example of a piece of stainless steel tubing drilled with the 'flow-drill'. One of the holes has been tapped proving that the bush has strength. A bonus is the fact the process does not create swarf. The firm operates a drilling service. Above left, definitely not for the home workshop but is this the lathe of the future? Sparks from a wire erode away the metal which is revolved in a chuck. An exceptional degree of accuracy can be obtained with the system which, it must be added, is not yet in use with industry. The method is normally used for precision cutting of thick metal components and was demonstrated by Sykes Machine Tool Company Ltd. Above right, called 'snaplocks', these fittings are available at many good tool stockists. They make a fully flexible system suitable for holding cooling hoses, safety shields, small drawings and a host of other applications. Another useful idea seen here is to hold cooling equipment in position with a magnet, ensuring that the coolant is directed exactly where it is required.

The editor visited a trio of major engineering exhibitions recently. What he found among the high-tech, full-size industrial innovations on display provides plenty of food for thought for model engineers.

1 990 is the year in which the engineering industry held their showpiece exhibitions at the National Exhibition Centre, Birmingham. Three different exhibitions were held simultaneously; Metcut 90 concentrates on machine tools, Metalworking 90 on the sheet metal fabrication industry and Subcon 90 is the showpiece of the sub-contracting industry which shows how modern technology has improved production methods.

Whilst it was fairly obvious that none of the exhibitions would have any direct relationship with model engineering and the home workshop, the editor went along to see what it was all about, and whether there were things for us to learn that could help in our hobby. All three exhibitions were absolutely fascinating and there was

plenty to interest anyone with even the slightest interest in engineering.

Subcon 90 probably had less to offer than the other two but even so it was quite enlightening to see some of the things on show and how mass production copes with them. Even though on the whole the sheer volume of parts produced at a time give the show little relevance to the model engineer there were plenty of items that were of interest and which we hope to explore at a greater depth later on.

For example, we saw a firm was showing a very advanced cutting lubricant, which is available in small spray cans. Another was demonstrating a device for cutting holes in sheet or tube, no matter what the metal. The holes were actually burnt through the metal and at the same time a bush was raised round the edge.

The system certainly has applications in the model engineering field, particularly in boiler-making. Enquiries showed the price to be somewhat higher than we think most model engineers would be prepared to pay but the firm actually operate a service of making the required holes in customer's own materials. The system is known as 'flowdrilling' and an ordinary drilling machine is used for the work.

Metalworking 90 offered little for the model engineer other than interest. Large pieces of metal were cut and folded as though they were tissue paper and it was indeed fascinating to watch. There were several laser cutters in operation which were interesting as in Subcon 90 some firms had been offering laser cutting on a jobbing, one off basis. This is a service which could be worth considering as it is not such an expensive process as might be thought. One firm in particular specialised in such work; this was Coventry Laser Cutting, from Coventry. They have subsidiaries in Kent and one in Yorkshire under the name of South Yorkshire Laser Cutting and certainly anyone thinking in terms of a $\frac{7}{8}$ in. gauge locomotive might like to consider the idea.

Metcut 90 showed how things really have changed in the engineering industry. There were few machines on view that were not in one way or another electronically controlled. Emco Maier & Company who the modeller knows well enough as importers of the Unimat range of lathes and milling machines showed their other face with a massive stand of advanced computer-controlled machines. There were plenty of small tool suppliers showing their wares and drills and milling cutters were around in plenty. The emphasis, however, was on carbide tools, either solid or tipped.

Linear Tools Ltd of East Sheen in London had plenty to interest the model engineer who wants to use new technology including diamond needle file sets which retain their edge for much longer than normal files. They also had plenty of different types of industrial diamond laps for honing tools. Possibly the most intriguing piece of all was a 'vee' block in a protractor base that allowed work to be set at any angle.

Although laser cutting is the in-thing there were several firms showing other methods of metal cutting as well. One particularly spectacular demonstration used a spark erosion system for both cutting very thick metal blocks and for turning. Spark erosion is usually employed for things like removal of broken taps and drills.

Now we know how much engineering has progressed it is hoped that use can be made of much of the information gained, to help readers to increase their skills in this direction. It is not just a question of speed, in fact, with a 'one off' speed hardly comes into it. It is accuracy that can be improved with these methods, and which holds the advantage for the home workshop. Accuracy in modern industry is measured in microns, not thousandths of an inch or tenths of a millimetre, and whilst we do not expect to be able to get quite that accurate we will hopefully achieve a considerable improvement for readers making use of technology demonstrated at Birmingham!

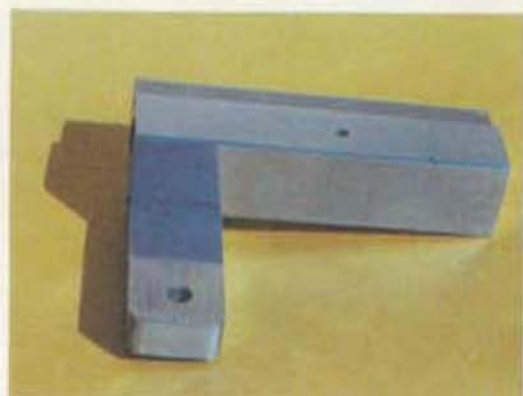
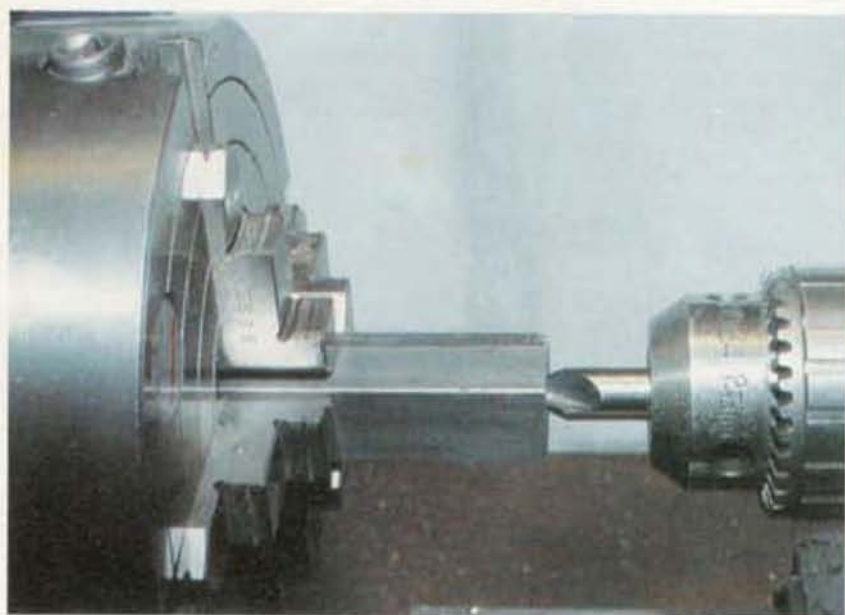


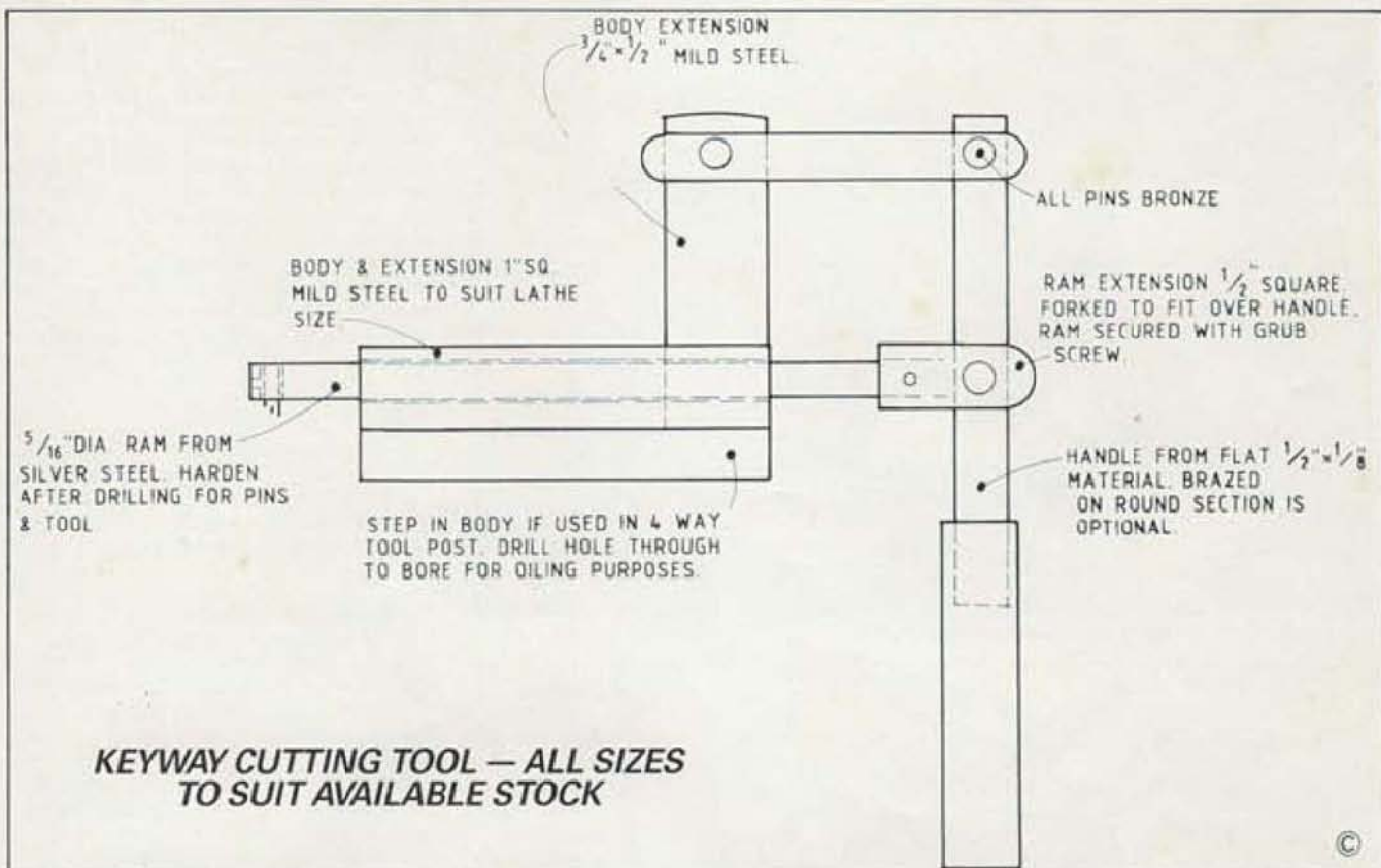
A U S E F U L

KEYWAY CUTTER

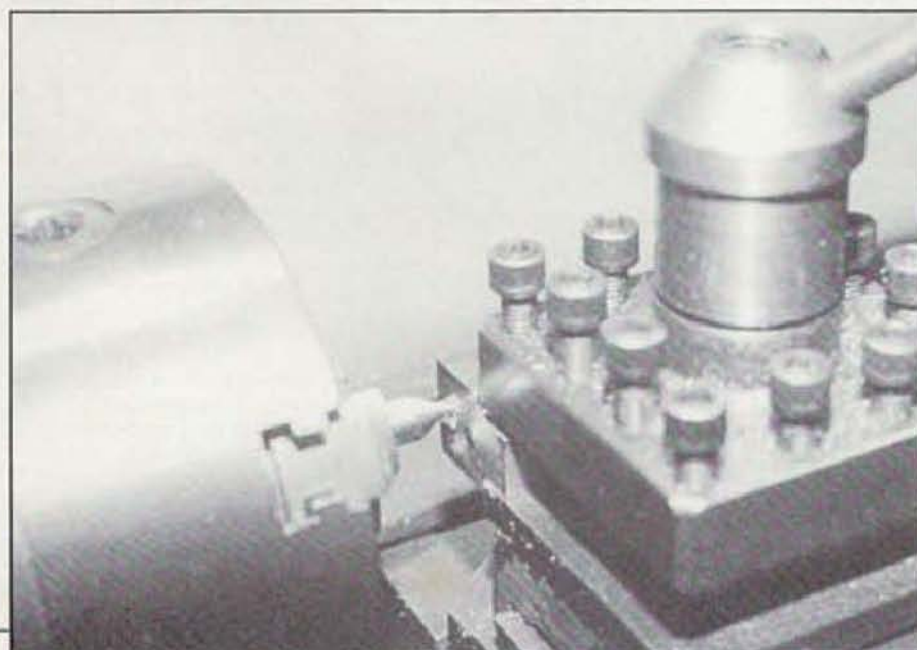
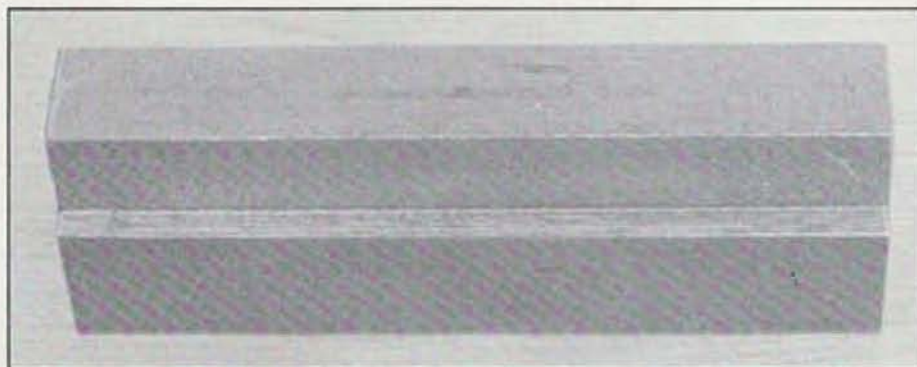


Top left, the finished Keyway cutting tool. Centre left, with the body in the four jaw chuck, line it up with a wobbler and use a centre drill to ensure that the hole will run true. Bottom left, drill right through the bar to the diameter that it is intended the ram should be. Below right, the handle and pivot bar. Note the bronze bush in the latter which slips over the pivot. Next down right, the support bar is bolted to the body with three screws set in a triangular position. Picture below this shows the support bar from the top. Bottom right, the pivot is mounted on the support bar. The top of the pivot block must be exactly the centre-line height of the hole through the body. Opposite page top, the male body is made from a piece of bar, either square or rectangular. If it is to be used in a four-way toolpost, a lip must be put on it for holding purposes, which can be either machined or screwed on.





Ever been stuck to put a keyway inside a flywheel on a stationary engine or even on a shaft? We show you the answer with this compact add-on feature for your lathe.



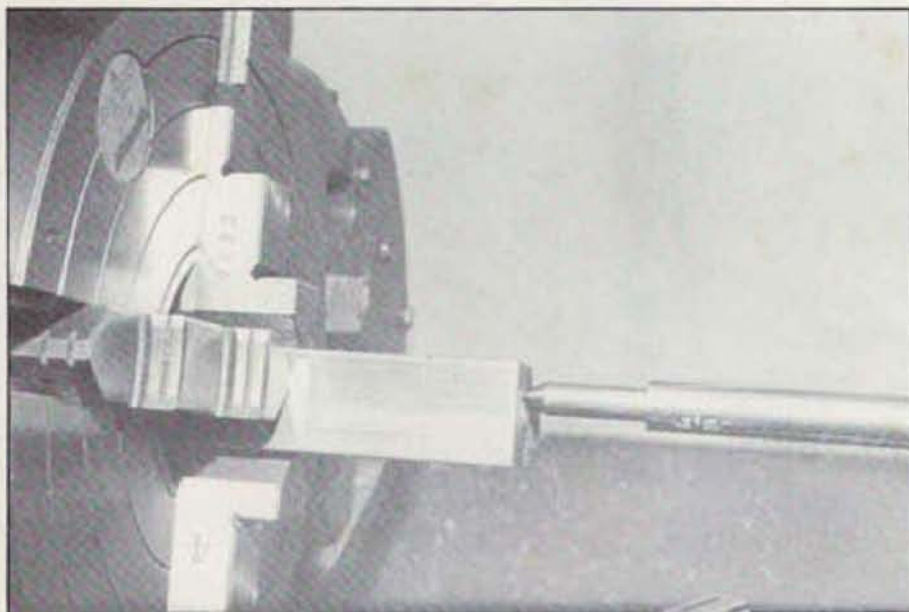
Anyone who makes model steam engines will almost certainly need to cut small keyways in order to key components together. Using a file is difficult in these circumstances as there is a natural tendency for the file to rock, resulting in a high spot in the middle of the keyway that is difficult if not impossible to remove. Normally, outside keyways are made with a milling cutter. The tool described here, however, will make both internal and external grooves and where very small sizes are concerned has advantages over milling.

Making a small keyway cutter is quite easy and, whilst there are some more complicated types, this design works well. As the design stands, the tool fits into a four-way toolpost, but would easily adapt for a quick change or other type. If the tool is mounted on the top slide and held with a clamp it will be necessary to either make the body considerably larger or pack it up on blocks. The recess which is there to allow the tool to fit in the narrower slot of the four-way post will not be necessary in that case.

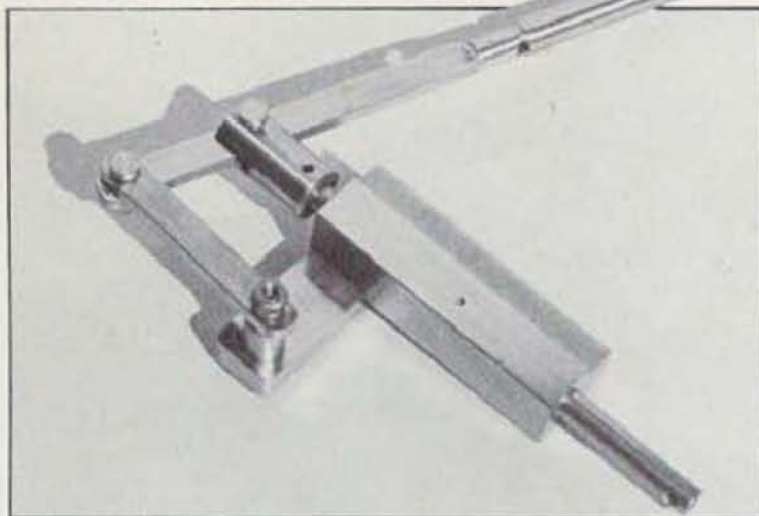
Dimensions must be to suit the individual machine, those given being suitable for a Myford ML7. The tool is made (apart from the tool/bit) from stock material and so again readers will want to adjust measurements to suit what they have around.

It will be seen that, as designed, the body has a tongue to allow it to be mounted. This can either be milled by putting it on the cross slide and running a milling cutter along each side or a piece can be screwed to the block.

Left, hold the body on the cross-slide and make a centre mark with a centre drill held in the lathe mandrel.



Put body in the four-jaw and line it up with a wobbler



Another view of the finished tool; it's probably not the sort of item you'll be using every day of the week but, when you do need it, you'll find it invaluable!

Below, the ram and ram extension. Latter is slotted to accept the handle and also drilled for the joining pin. The ram is cross-drilled for the tool and end-drilled for the grub screw which locates it. The arrangement allows for the fitting of other ram sizes.



The body

The body is mounted in the toolpost and marked with a centre drill held in the chuck. This ensures that the hole will be at exactly centre height. The hole could be drilled from the chuck if one so wished, but it may be found easier to turn the body round, put it in the four jaw chuck and adjust it to run centrally, using a centre finder. The hole can then be drilled. The size shown is $\frac{1}{2}$ in. as this allows keys to be cut directly in a $\frac{1}{2}$ in. diameter hole, a fairly common size. It is also possible to use the tool for larger holes and with adapters for smaller ones. Anyone building large-scale traction engines will want to make the ram larger 'no doubt' and so the hole must be

drilled accordingly.

Pivot support

The support for the pivot was milled to form a lip but could be fitted straight on the bottom of the body, making the pivot pin longer than shown to make up the difference. It is secured with three cap head screws. These give a good firm support and plenty of strength. Actually, it would be nice if a casting were available as it would also help with the bearing surface for the ram as well as obviating the need to fit a pivot block.

The ram

The ram should be made of silver steel,

if the body is of mild steel. It can be cross-drilled for the tool and then drilled and tapped in the lathe for the holding screw. The end piece is of mild steel and was first bored to accept the ram and then cross-drilled and slotted for the handle. Finally, it was drilled and tapped to accept a screw to secure the ram to it. The ram is hardened after completion to prevent too much wear as it is running in mild steel. There is no reason why, if one wishes, the body should not have bronze bushes inserted, in which case the ram could be made of mild steel. It can also be of mild steel if the body is made of cast iron.

Pivot arm

The pivot arm is ordinary mild steel strip, drilled to accept the pin which connects it to the handle and bushed at the other end with a bronze bush to slip over the steel pivot attached to the body.

Handle and cutter

The handle is made from the same material as the pivot arm and is drilled for the pins. How it is finished is a matter of choice. It can be left as it is and will work quite successfully. The one shown has a small piece of tubing riveted to it for comfort. Whatever happens, do not make it too long as when cutting a keyway the work should be done gently and a long handle will apply too much pressure.

The two pins are of bronze and are simple turning operations. The cutter was ground from a piece of $\frac{1}{2}$ in. diameter high speed steel. There is no need for any special shape; just grind exactly half way across the diameter, and a slight angle on the cutting edge. The curvature of the steel will provide sufficient clearance for the tool edges.

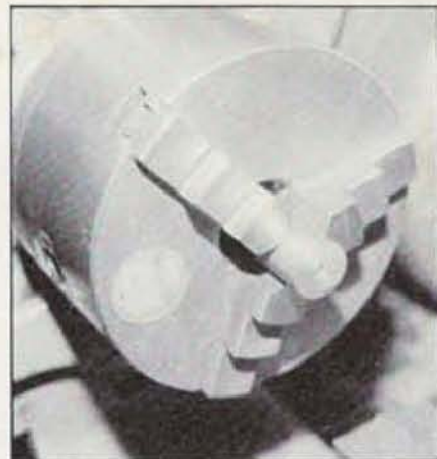
Smaller cutters

That basically is it. If smaller cutters are required it will possibly be difficult to obtain high speed steel of a suitable diameter. They can, in that case, be made of silver steel and hardened and tempered. They can be mounted in the same sized ram if the bore of the component allows. Otherwise they will have to be put in a ram with a step turned on it — the alternative being to make up a spare ram of the same diameter as that shown and drill it for securing screws to hold smaller diameter material suitable for the keyway being machined.

Another method is to turn a silver steel bar so there is an off-centre recess, and to shape the tool on the end with a file, subsequently hardening and tempering as required. In this case, the end going through the body can either be of full diameter or, as already suggested, recessed into a suitable bar.

It is quite possible to cut keyways as small as $\frac{1}{16}$ in. wide with the tool, but when getting to these small sizes the ram and the tool will, almost certainly, have to be integral. The tool does not take long to make. It is the sort of thing that is rarely used but is absolutely invaluable when it is needed. It can also be used for marking graduations, by inserting a pointed tool in the ram. Suitable length stops for the graduations would be required in this case.

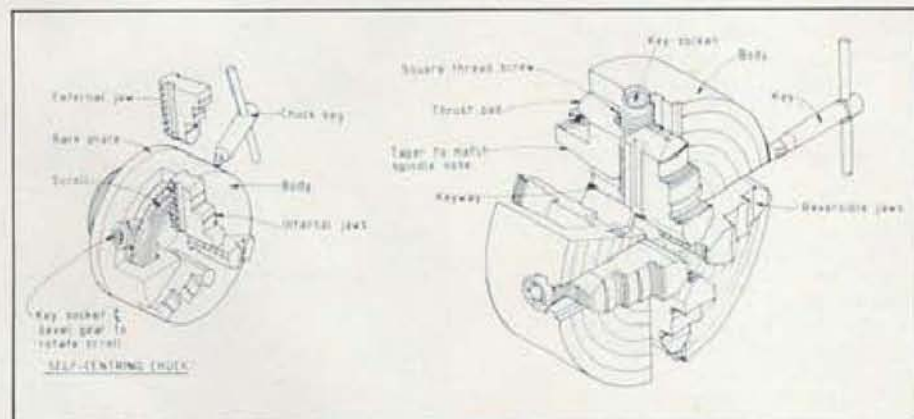




The standard three-jaw geared scroll chuck (like that above and left) is useful for holding round or hexagon bar but likely to lack accuracy.

CHOOSING A CHUCK

The chuck is something which most model engineers take for granted, and yet it is a most necessary piece of equipment. During the course of the hobby we will use chucks on the lathe for two different purposes; one use will be to hold work, the other will be for holding small tools such as drills.



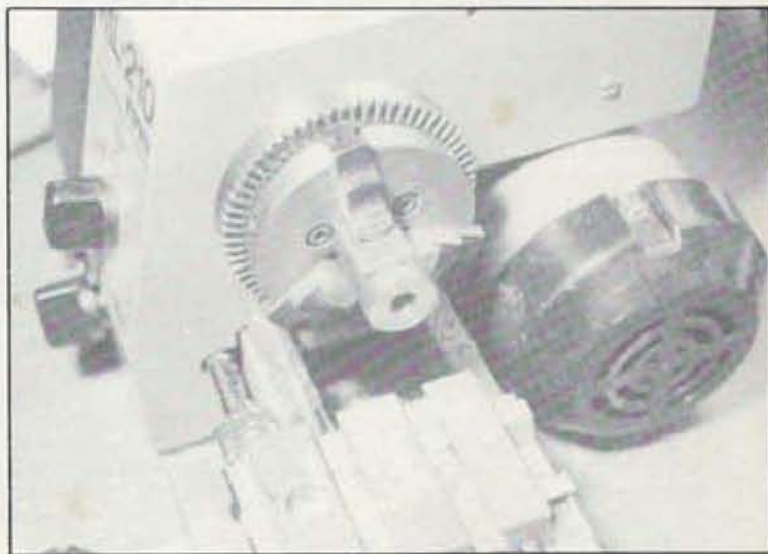
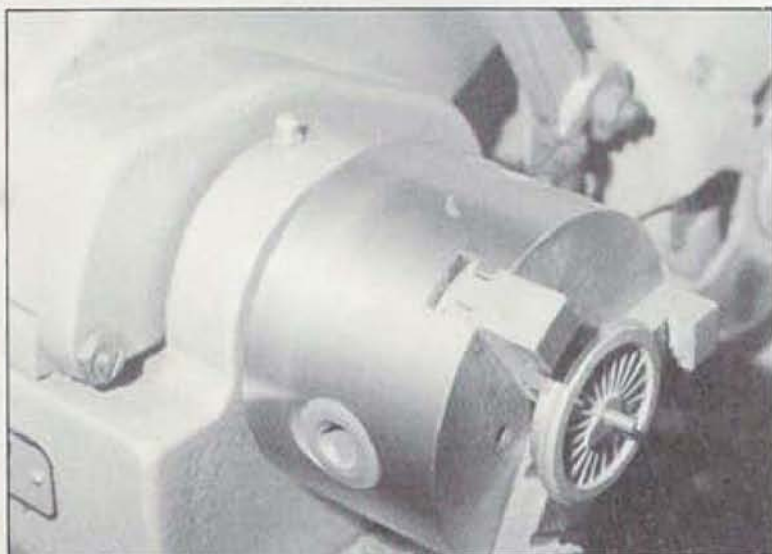
The three-jaw lever scroll chuck, seen here with 'outside' jaws used to hold a small locomotive wheel.

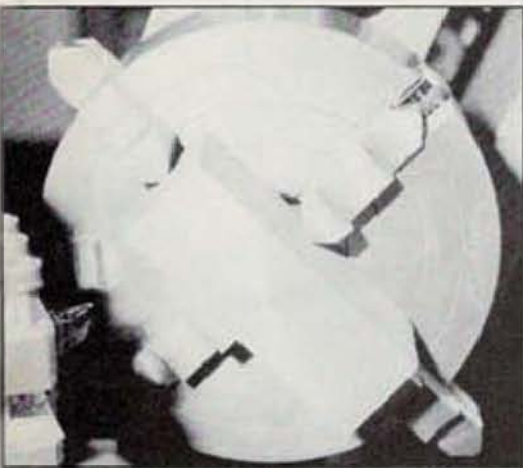
This is a geared scroll chuck which works on the same principle as the drill chuck. Usually found on small lathes.

Let us for a start think of the types of chuck commonly used on the lathe. There are many different types available to the professional engineer and if one visits a large engineering works it becomes obvious that some are retained for use when needed on special work. As far as the model engineer is concerned, with prices of chucks very high, we will want to make as much use as possible of the chuck, and so basically will be interested in two types for work holding.

Three-jaw self-centring chucks

One of these is the three-jaw self-centring chuck and, whilst here again there are differing ways in which such a chuck





A four-jaw chuck, seen here holding a conventionally shaped metal bar.

will operate, as far as usage is concerned it will not matter what the construction is. As the name implies, when work is put into a three-jaw self-centring chuck, as it is tightened it is automatically centred, within the limits of the accuracy of the chuck. All the operator needs to do is to turn the chuck key or, in some cases, operate two levers and the three chuck jaws close round the work. This is fine providing the work is either round, triangular, hexagonal or some similar regular shape which can be gripped on its edges in three places and will run as truly as the chuck will allow. In practice it really leaves only round bar and hexagonal material to be used directly in the chuck — three jaws locating, for example, on a square section just will not allow it to run evenly, even if the jaws will actually grip the material.

Lack of accuracy

There is another problem and that is getting a chuck which, in the first place, runs true. Not many do, the majority being sufficiently far out to make accurate work impossible. There are several reasons for the fact that the jaws are not running true, but mostly it will be as a result of wear or possibly lack of accuracy in the original fitting of the chuck — it can also be caused through dirt getting into the various parts. Chuck jaws usually wear at the end and an effect known as 'bell mousing' is the result. The scroll that operate the jaws also wears and as it does not wear evenly, here again, the jaws can be forced out of true.

A third cause can involve the backplate. It is possible to purchase chucks that fit directly onto the lathe mandrel but most of the larger ones are first fitted to a cast iron plate known as a 'backplate'. This is obtained as a rough casting but may already be machined to fit the lathe mandrel. The casting has to be turned to fit a recess in the back of the chuck and it goes without saying that such machining needs to be very accurate to get the correct fit. Problems can also be caused by a build-up of swarf between the backplate and chuck; this is remedied by regular cleaning. It is possible to adapt a backplate so that it can be adjusted for accuracy, and Hemingway sell a drawing which gives details of this. If a new backplate is being machined, or indeed if an old one is giving trouble, then it is well worth while making such modifications.



Work held in a four-jaw needs setting to get it true. Here a centre-finder is used in conjunction with a centrepunch mark. A height gauge can also be used by making adjustments to the work position and checking it against the scribe in the height gauge.

Living with the faults

The fact that a three-jaw chuck does not run truly does not mean that all is lost. Providing the amount of error is known, and the jaw on which that error occurs identified, small metal shims can be used to correct the fault. These can either be stuck to the chuck jaw with cyanoacrylic adhesive (superglue) or inserted as required. Correcting faults on worn scroll threads, alas, is not quite so easy, and the alternative is to try and purchase new jaws for the chuck.

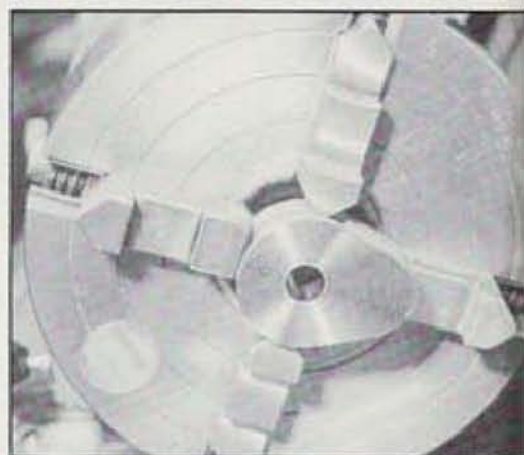
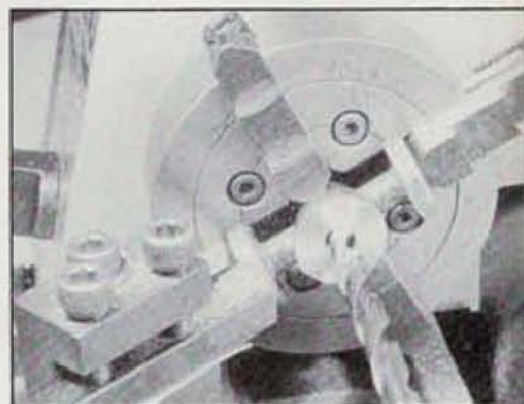
Four-jaw independent chuck

The other type of work-holding chuck most commonly found in the workshop is the four-jaw independent. Here, there are four jaws and each is tightened up separately. This means that there is no automatic way of centring work; it must be adjusted by the operator. To the beginner, this may sound rather daunting but, in fact, it is a simple process and once one gets used to it, adjusting work in the chuck can be very easy. At least by adjusting the work for yourself it is possible to get it perfectly accurate, whereas with the three-jaw self-centring type, it becomes a case of take it or leave it. Another advantage of the four-jaw independent chuck is that square, rectangular or irregular shapes can be held as well as round and hexagonal stock.

Four-jaw self-centring chuck

It is also possible to obtain a four-jaw self-centring chuck, although these are not often found in the model engineer's workshop. Such a chuck can, of course, hold square bar as well as round stock, but it will not hold hexagonal bar. The chuck, like the three-jaw self-centring, is ideal for quick setting up, but is also likely to lack

At right top, a four-jaw chuck used to hold a flywheel; the jaws are reversed to hold this large diameter casting. Right centre, the four-jaw independent chuck is very versatile. Here we see an unusual-shaped casting being held for drilling, the independently controlled jaws easily accommodating the irregular shape. Bottom, another odd-shaped casting in the four-jaw; this is a traction engine hub and three jaws are in the normal position while the fourth is reversed.



accuracy for the same reasons. All three types of chuck will usually have jaws which can be reversed or separate jaws which fit in the reverse position, in order to hold larger sized work. The self-centring types need to have all the jaws reversed when used in this mode. The four-jaw independent can be used in any variation that one might wish, and this can be very handy for odd-shaped work.

Drilling chucks

It is usual to use a smaller chuck for drilling, held in the tailstock, and the type will be familiar to most readers. When fitted to a lathe they are usually held in place with a Morse taper although the Unimat Three in fact has an arrangement whereby the drill chuck screws onto the tailstock mandrel. Drill chucks are available in various sizes, and in many ways it is a good idea to get the largest one that will fit the lathe or drilling machine as it will then hold larger drills. However, the larger chucks, particularly those of inferior quality, will not always hold small tools as well as we would like and so there may be a case for not getting too large a chuck. If small drills are to be held in a large chuck then they can be put in a small subsidiary chuck, known as a 'pin chuck', first and this will enable the large chuck to take a better grip.

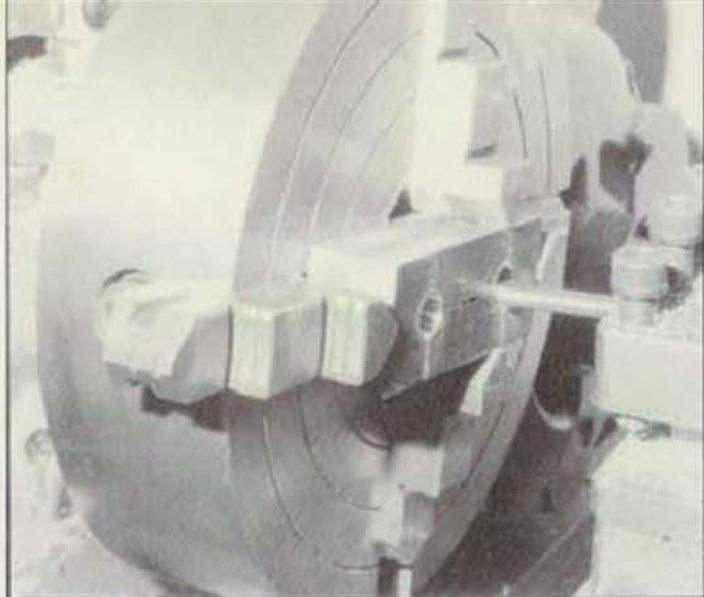
If drilling from the tailstock, it sometimes happens that several different sized drills may be needed and changing drills in an ordinary chuck is a time-consuming business. The answer here, is a keyless chuck which tightens up by hand pressure only; these are very effective and quick to use. However, unless of a decent quality they can lack accuracy, as some work on a principle of having only two jaws which are closed by a screw pushing from the rear and unless the drill is placed in the chuck very carefully it can easily be moved off centre by the tightening process. It is therefore advisable to ensure that any keyless chuck bought for lathe work has three jaws and that, when tightened, these are accurate.

Buying a chuck

To return to our work-holding chucks, we can give some thought to what is the best type to go for when purchasing a lathe. Most suppliers tell me that customers always ask for a three-jaw self-centring type when they purchase their lathe but this is not really the best chuck to get as an all-purpose holding device. As already pointed out, it will only successfully hold round or hexagonal work...

We can, however, increase its use a little by making up small collets to hold square bar for machining. These are made from mild steel and are drilled with a hole the size of the distance across the corners of our metal bar. The collet is then split and the bar passed through it. As the chuck jaws close so the collet will tighten on the work and hold it reasonably accurately, depending to some extent in the first place on the accuracy of the chuck. If lips are left at each end of the collet this will prevent the collet sliding off the jaw as the metal is passed through it.

For the newcomer, particularly if on a tight budget, a four-jaw independent chuck is the answer. It will not take long to learn to set it up and it will do a whole variety of work. Sometimes a lathe might be received



Another illustration of the versatility of the four-jaw; here two holes are being bored in a bar. The independently adjusted jaws allow the work centre-line to be maintained in one plane while it is pushed across for the boring of the second hole.

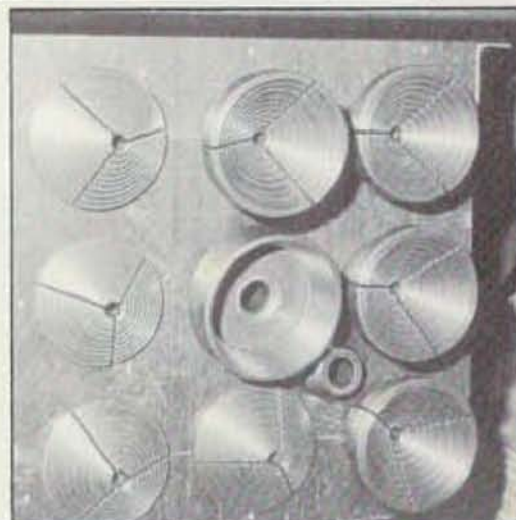


The normal type of tailstock chuck; usually retained by a Morse taper, it is used to hold drills and other small tools.



The Keyless chuck (above) is useful where a number of drills need changing. Right, a set of bell chucks. These are used for holding thin, large diameter work and we'll show you how to make a set in a future issue.

with just a faceplate. Do not despair because there is no chuck; a faceplate can hold almost any work. Usually the work will be held to it by brackets and clamps but it is possible easily to make some simple jaws that will clamp to the faceplate and make it very versatile indeed. These jaws, once made, will usually hold virtually any work no matter what the shape and are no more difficult to set-up than the ordinary four-jaw chuck. Next time we will go into this matter a little further, with drawings and constructional details for this type of attachment for the Faceplate.



HOME MADE PRE

When you are setting-up work or marking out, do you sometimes sigh "oh for a pair of eyes"? In this ingenious feature 'Bluey' comes to the rescue with an easily made pair of aids for your workshop. You'll find this optical centre-punch and centre-finder indispensable and they'll cost a fraction of what you'd pay for commercial items.

O P T I



The completed optical centre-finder in the milling machine; in actual use it would be brought closer to the work than shown in order to line it up accurately.

Centre punching is a tricky business although in theory there is nothing to it! What *should* happen is that the centre punch should be used at the junction of two scribed lines and should be drawn along one until the intersection is felt and then at that point tapped with a hammer. I am sure most of us follow this excellent advice only to find that the punch has slipped out of position before being hit and we then have to start laying it at an angle and trying to retrieve the position. (It is rather like sawing the legs of a chair to make it shorter — we keep going a bit more and a bit more until the whole thing becomes quite a mess.) The result is often an elongated punch mark more or less on the spot required but because of its shape, a drill, and particularly a small diameter one, is likely to wander some way from where we really want it to be.

The optical centre punch

I had seen advertised an optical centre punch and at an exhibition actually saw one. I must say that I was quite impressed.

However, buying things that can be made is not my way and so next day it was into the workshop and a start was made on scheming out an optical punch for myself. Although made from odds and ends which happened to be around my own workshop there is nothing required that is not very easily obtainable.

The actual punch is 3/8ths in. diameter and, whilst my own was already around in the workshop and was pressed into use, there is nothing difficult about making one from silver steel, hardening and tempering it to a straw colour. The actual sizes shown suited me, but there is no need to comply with them if convenient materials are to hand. The point on the centre punch is

shown as an included angle of sixty degrees, which is the angle I prefer. Technically speaking, the angle should really be ninety degrees to allow the drill to seat better in the punch mark, sixty degrees being normally used for initial marking-out and the mark then opened out with a punch at ninety degrees. However, all this is a matter for the individual.

The support body

The support body was machined from a piece of 1in. diameter aluminium but could just as easily be mild steel or brass if these are more convenient. The central hole should be bored or reamed to a good fit as there must be no slop on the punch when it is inserted. A groove is machined in the end and this accepts an 'O' ring which stands just proud of the actual body and so prevents the thing from sliding around whilst being lined up.

The insert

The original optical insert was made from perspex and actually machined from a piece of sheet material, no other being available. Also, originally it was parallel; there was no magnification and not as much illumination as one might have wished for, so, whilst visiting the 1990 Model Engineer Exhibition, I purchased a piece of 20mm diameter acrylic rod from College Engineering Supplies. I then made a new insert with a domed top which gave more light at the base and also provided a degree of magnification. Acrylic is not quite so easy to machine as perspex as there is a tendency for it to string. However, both are quite reasonable to work with.

Polishing

The insert must be highly polished and this was done with Solvel Autosol which can be obtained from most car accessory shops. It is rubbed on with a cotton cloth and then buffed hard to give a good finish. I should point out that it is essential that the original machining must also be to a fine finish to prevent excessive polishing being required. I also polished the support body by the same method.

Very fine marks (cross hairs) must be made across the bottom of the insert and these line up at the place where the centre punch mark is to be made. These can be done in the lathe using a sharp pointed tool which is drawn across the face, the lathe then rotated through ninety degrees and the operation repeated.

PRECISION

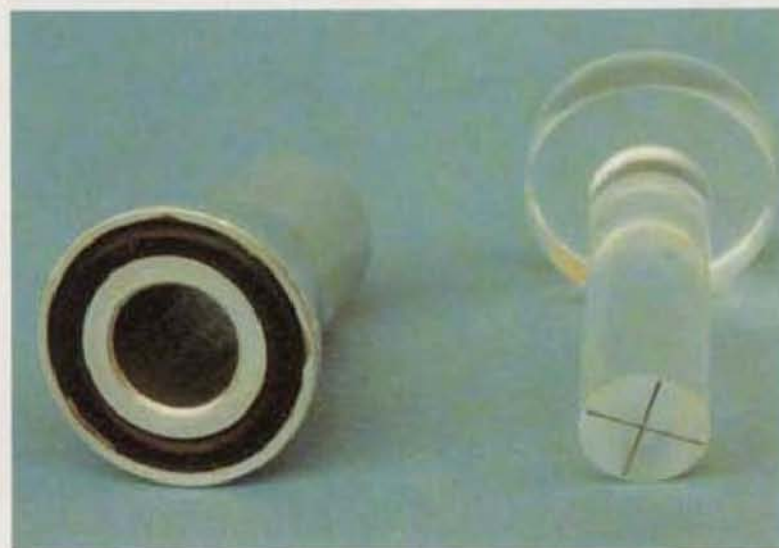
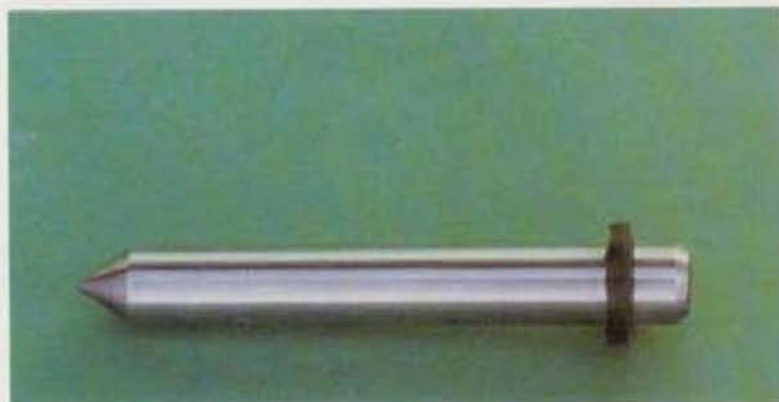
C S

Of course, such an instrument relies on accuracy in the first place. There must be no slop on either the optical insert or the punch, as this would immediately lead to errors when in use. Care must therefore be taken to ensure that the point on the punch is made accurately. If the three-jaw chuck of the lathe is not one hundred percent accurate then set the punch up in the four-jaw chuck. Failing this, use a larger diameter piece of metal than required and turn the parallel shank and the point in one setting. Part off the excess larger diameter material and the punch *must* be right. Similar precautions must be taken with the insert and, in particular, care must be taken to ensure that the tool used to scribe the cross hairs is absolutely on centre height.

The centre-finder

The centre punch proved a delight to use, making marking-out both extremely quick and very accurate. Fired with enthusiasm, I looked at a very expensive piece of equipment in the form of an optical setting-up guide. We all know the problems; some form of pointer or a wiggler is put in the milling machine and

Top left, the body of the optical centre punch; this one is from aluminium but almost any material will do. Top right, the magnifying lens for the tool. Made from acrylic, it is a simple turning exercise; shank must be a good sliding fit in the body and the large diameter rounded at the end to provide magnification. Next down, the centre punch. This, too, should be a sliding fit in the body; the 'O' ring at the top has no effect on the operation of the tool but makes it easier to handle. Next down, the ends of the body and magnifier. The 'O' ring recessed in the body prevents accidental movement when adjustments are made. Black felt-tip pen ink wiped over the base of the magnifier picks out the cross-hairs. Near right, the body with magnifier ready to be positioned over the work. Far right, when the body is in the correct position the magnifier is removed and replaced by the centre punch.





brought to the work. Sometimes the setting can be done quite easily and no real concentrated visual observation is needed. On other occasions it is impossible to get the light exactly as required to see what one is up to, and if the light shines on the point of interest then it casts a shadow that makes it impossible to see exactly what is happening. Usually in these circumstances we resort to the use of a magnifying glass, which invariably is covered with dirt when needed, or hides itself away in a corner of the workshop (like on the marking-out bench) and cannot be found until other methods of setting up have been resorted to!

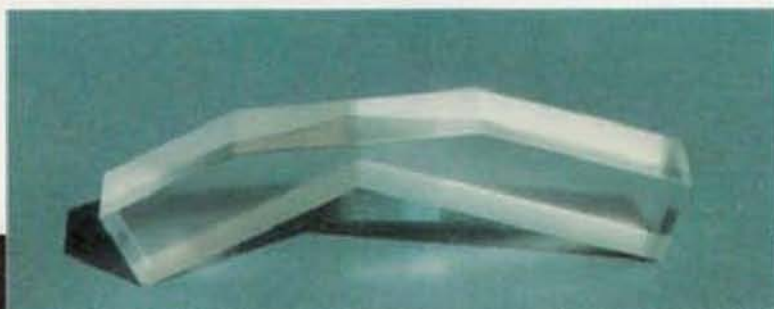
But an optical centre finder sounded quite formidable, and judging by the price they must be made of pure silver. So if I can make an optical centre punch, why not an optical centre finder? I picked up a piece of aluminium of what I thought would be a suitable diameter and started experimenting. Originally I made the optical insert from two pieces of perspex which were to be joined. That caused problems as any adhesive would have upset the optics. I then hit on the idea of making it from a single piece of material.

The material I used was thicker than required and was very scratched and so I had to machine all faces. This will not be necessary if the correct thickness of material is available. Perspex is not hard to come by in sheet form, a quick look in the Yellow Pages under plastics will, in most areas, reveal several suppliers and most of these keep boxes of odds and ends. The betting is that if you pay a visit to one then you will come home with bits of PTFE and all sorts of things.

My thicker diameter material was fly-cut with a very fine feed and this produced an almost polished finish all over, the only parts that really have to be polished up to a mirror finish are the two square ends and the twenty two and a half degrees chamfer. Again Solvol Autosol was used for the final polishing.



Top, the assembled optical centre-finder; it is absolutely essential that the lens lines up centrally in the body if accuracy is not to be impaired. Next down, back to the optical centre punch instrument for a moment and a good view showing the inked cross-hairs. At far left, the body of the centre-finder showing how the slot has been milled out to accept the lens. Near left, this frontal view of the body shows the two angles required accurately to position the lens. The angle value of the body itself is not critical, provided, of course, that it is matched precisely by that of the lens. Below left, the centre-finder lens. In the prototype, this was cut from a sheet of Perspex and polished. The angle enables the operator to look round the corner to the point of setting.



The body

The body was made, in my case, from 1 in. diameter aluminium, but brass or mild steel would do equally well. The bar was first machined as required in the lathe and then the slot was milled out with a 3/8 in. diameter cutter in two separate operations. The first operation was to machine a slot 11/16 in. deep and 3/4 in. long. The work was then carefully re-positioned in the vice and a second slot machined at an angle of forty five degrees so as to intersect the first slot at 3/4 in. from the end.

Assembly

The two components were assembled ensuring that the protruding end was parallel to the body. To do this, temporarily fix it in place, stand the assembly vertically on a surface plate or, if you do not have a surface plate, on the drilling table or some similar object. Check right round the body to ensure that it is upright. When you are quite sure it is right, the assembly can be permanently secured with an epoxy adhesive ensuring that the adhesive does not touch the polished twenty two and a half degrees angled face. When the adhesive has thoroughly set, any excess can be scraped off.

The whole unit is now mounted in the lathe ensuring it is absolutely centralised, and the cross hairs engraved in the same manner as with the centre punch.

Using the centre finder

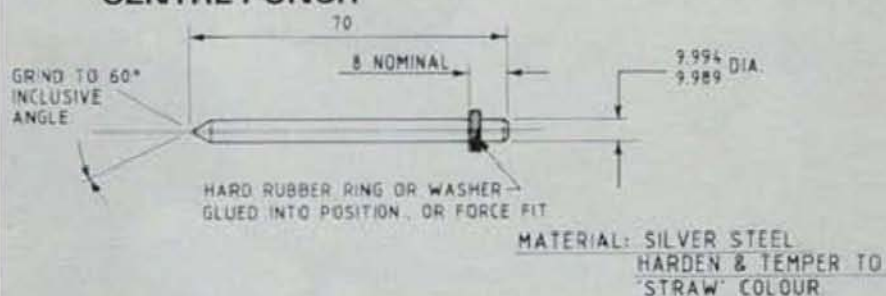
To use the centre finder, mount it in the spindle over the work. Adjust the table in either direction until the cross hairs are located exactly at the point required. Lock the table in position and raise the spindle to remove the centre finder which is replaced with the cutter. Do not, of course, alter the table position until cutting has started.

The tool proved remarkably easy to make and is one of the most useful little devices I have ever made.

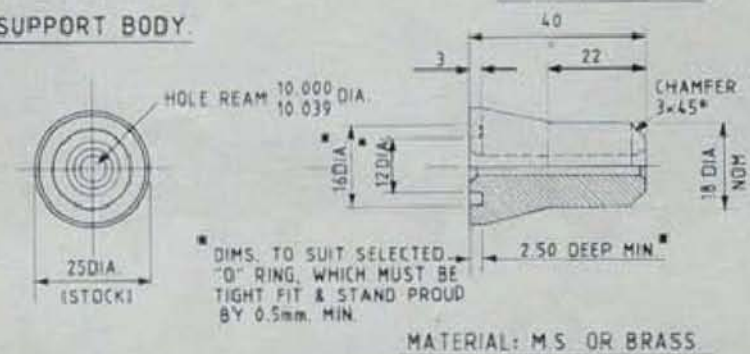
A final view of the optical centre punch outfit; left is the punch itself, at right the support body and sight.



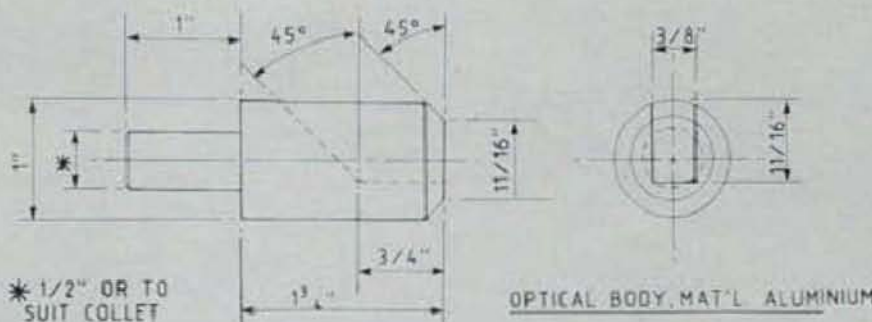
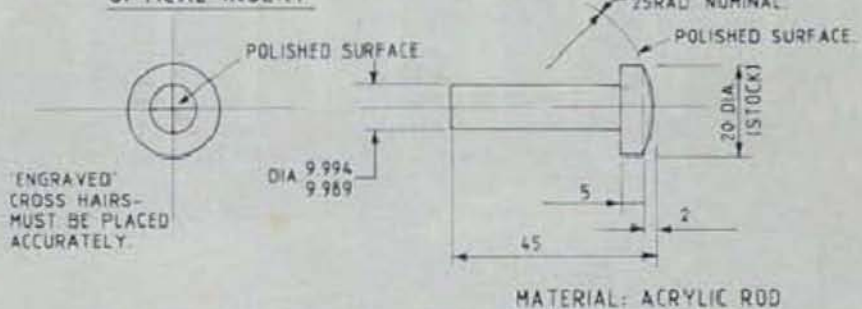
CENTRE PUNCH



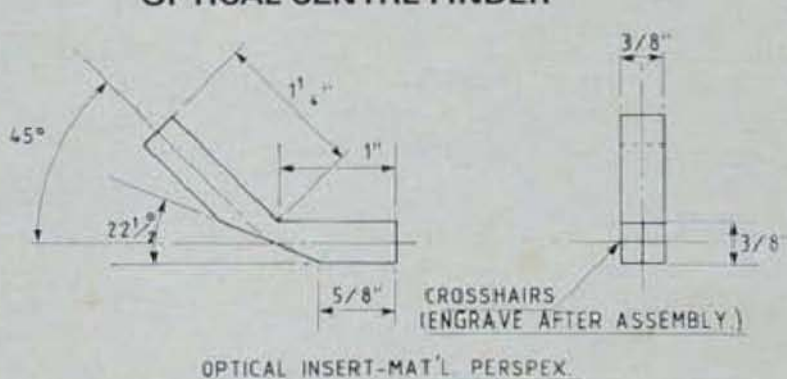
SUPPORT BODY



OPTICAL INSERT



OPTICAL CENTRE FINDER





A high quality all-steel vice with built-in anvil which can be used for hammering work. Don't attempt hammering work in the more common cast iron vice.

BENCH VICE VERSATILITY

One of the first pieces of equipment you're likely to buy when setting up a home workshop is the ubiquitous bench vice. Here we describe how to get the best service from yours... and offer a few gadgets to make it even more useful.

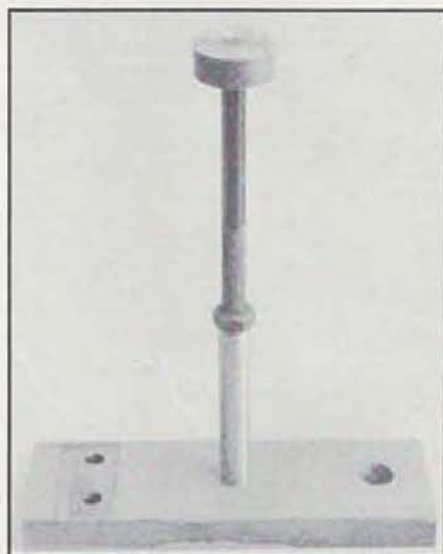
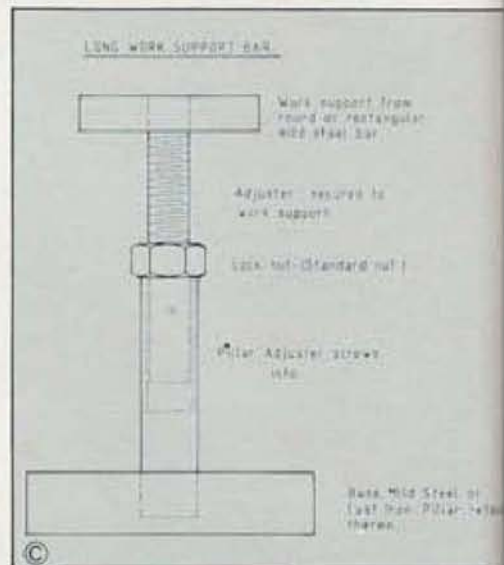
It is doubtful if many home workshops do not include a bench vice in their equipment. Even those who have no permanent workshop but have to stack everything away after use will, I am quite sure, own one of the small portable type that can be clamped to a table. We do, however, take our vice rather for granted, no doubt because it is basically a very forgiving tool.

Little maintenance is needed with a vice; the occasional oiling of the lead screw and a quick brush down to get rid of some of the dust and there it is all ready for the next time it is put to use. This does not mean however that we should deliberately misuse it as, with a little care, we will only ever need to buy one vice, unless we want to change to one of a different size at some time.

Hammering on the vice

When purchasing a vice, the largest size practical should always be bought, as there will inevitably come a time when the vice we have is not quite big enough in one way or another! More expensive models may be made of cast steel, but, as a rule, they will be of cast iron, and quality will depend on the price paid. Whatever the cost, assuming that our vice is cast iron, we must remember that cast iron is brittle. This means that hammering of objects held in or on it should be kept to an absolute minimum to avoid the danger of the casting breaking. Once this has happened then almost certainly the vice will be beyond repair.

Some vices have small built-in anvils and these are designed to take shocks and so should always be the part used when



The long work support described in the text. Ignore the holes in the base; the support was made entirely from scrap materials and the base metal just happened to have them drilled in it! The support can be round or rectangular as required, or as availability of scrap material dictates.

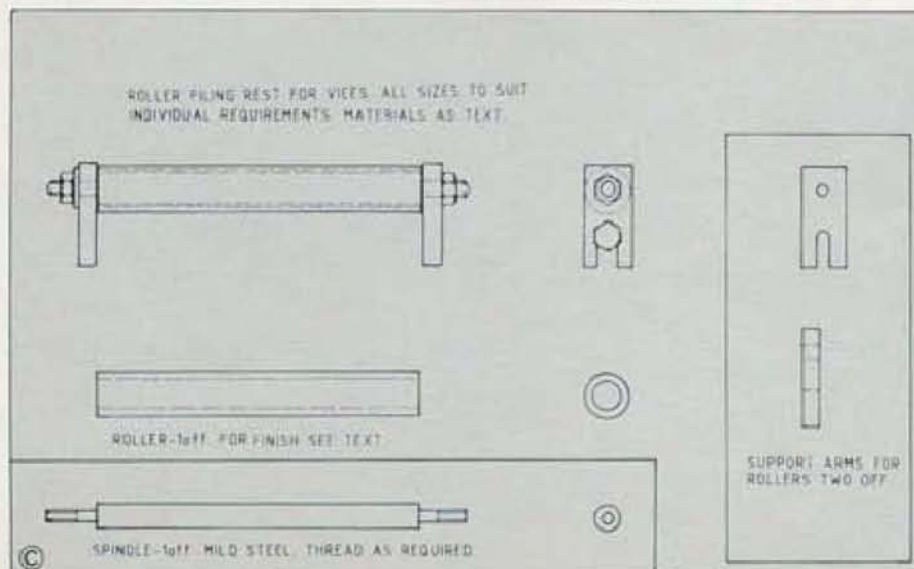
hammering is to take place. If it is just a plain vice then it is probably worthwhile investing in one of the cheap little anvils that are available to use for work that needs such treatment. These will take any amount of force and come to no harm. During the long life of a vice it is inevitable that the casting will receive some damage such as file and saw marks, but care must be taken to keep these to a minimum.

Excessive force

Never use excessive force to tighten a vice since this can damage both work and the vice. Ordinary hand force on the handle should always be sufficient to secure any work. Hitting the handle with a hammer is only likely to cause damage.

Removable jaws

Any reasonable vice will have hard jaws, which are usually serrated, screwed to the



casting with countersunk screws and can usually be replaced with new ones if they become damaged. They are rather fierce on work and will cause considerable marking when tightened on to even a hard steel which means that, on softer metals, the jaws will literally tear the metal apart. Separate soft jaws that clip over the top of the existing ones can be used to cover them and to hold work without marking it. Such jaws are made in a wide variety of materials, the most frequent being fibre. They can also be bought in plastic of various types and a set should always be to hand.

Making soft jaws

It is not difficult to make one's own soft jaws. Zinc sheet bent round the originals will make very good examples which give a good grip on most work. Pieces of aluminium angle will also do the job quite well.

Probably a better idea is to make soft jaws of a more permanent type to fit the vice. This is quite easy. Simply unscrew the fitted hard jaws and, in place of them, put jaws of mild steel strip which have been drilled to fit. Care should be taken with the drilling to ensure that the jaws line up properly. Aluminium and brass jaws can also be made up and these will protect any work that is to be secured.

The only difficulty likely to be found in drilling the new jaws is getting the width between the screws correct and there are two ways of coping with this. The first is to clamp the new jaws hard to the originals and drill through the existing holes. Alternatively, measurements can be taken. The best way to do this is to use a pair of dividers and check between the inside of one hole and the outside of the other. That is the way the examples shown were measured and the fit is perfect.

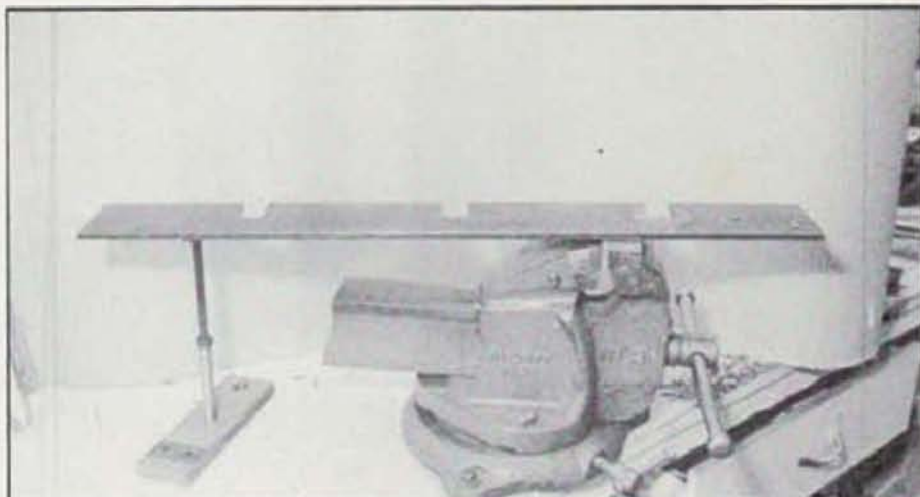
Other attachments

There are other attachments we can also make to get more from the vice. Illustrated is a simple filing rest. It is made to fit the individual vice and does involve some drilling of the casting. However, to ensure that this is not weakened, only small screws such as 2 B.A., $\frac{1}{8}$ th in. or 5mm bolts need be used. The holes which are drilled and tapped must be reasonably accurately sited and to ensure they are both the same height it is as well to measure with a height gauge on the bench, set at the required height. The distance from the jaws can be checked with odd leg callipers.

The rollers can either be left soft or hardened, there being two schools of thought on which is the best method. Certainly if it is hardened it will not wear and should not (if it rotates easily) wear the file out either. However, hardening such a component is not within the scope of everyone and if left soft then it can be machined true from time to time and is easily replaced if one wishes.

The spindle needs no explanation but it is as well to note that the supports have one drilled hole and one slot to allow the device to be adjusted to the correct level. Two slotted components could be used if desired.

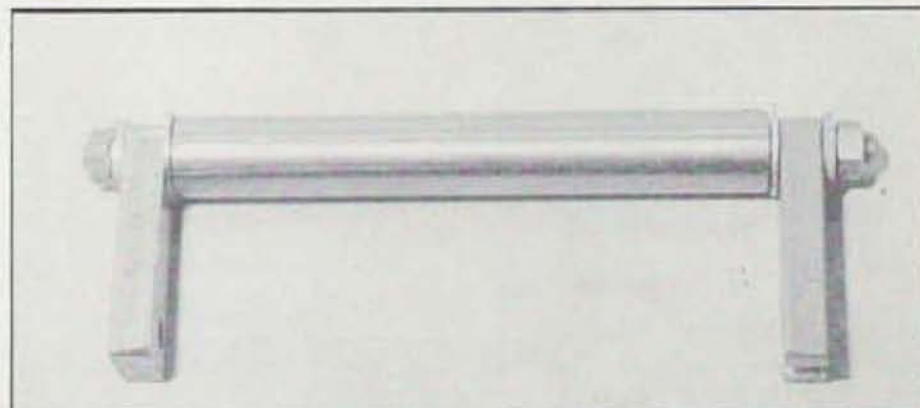
The second little device is almost too silly for words and yet it is worth its weight in gold. It is plainly a rest for long work, the sort of thing required for model locomotive frame riveting, etc. It can be made from any



The support in use for riveting the horn blocks to a model locomotive frame.

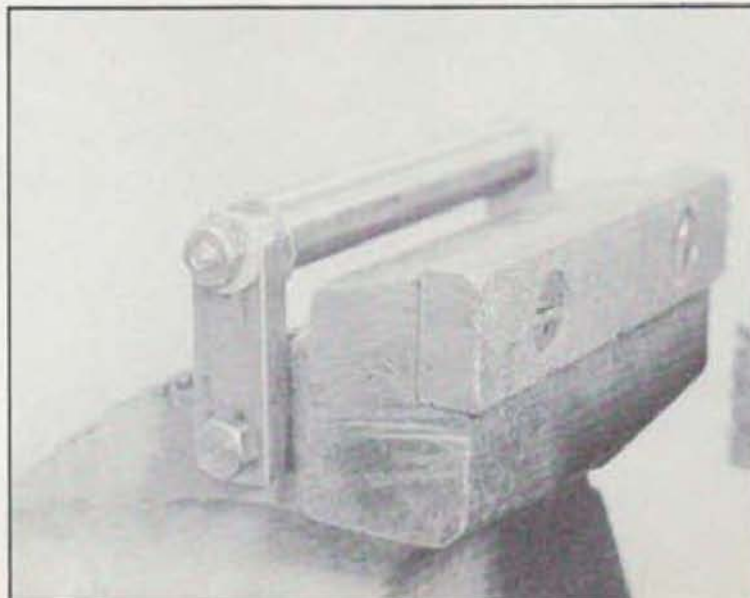


The parts of the filing rest for the vice. Both supports can be slotted if it is felt that extra adjustment is needed.

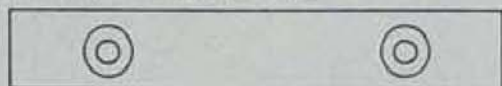


The completed roller filing rest; adjust the dimensions to suit your own particular vice.

The rest in position on the vice. Note how the supports bolt to the vice; diameters are kept to a minimum to avoid weakening the casting.



SIMPLE SOFT JAWS FROM MILD STEEL, BRASS, OR ALUMINIUM.
Make to suit individual vice.

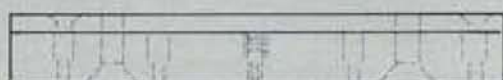


Parts for the sprung jaw; the backplate is attached with countersunk screws and keeps the sprung plungers in position.

SPRING JAWS ONE ONLY REQUIRED-ALL MILD STEEL
EXCEPT BRASS PINS & SPRINGS FROM PIANO WIRE.



C/SUNK SCREWS RETAIN BACK PLATE



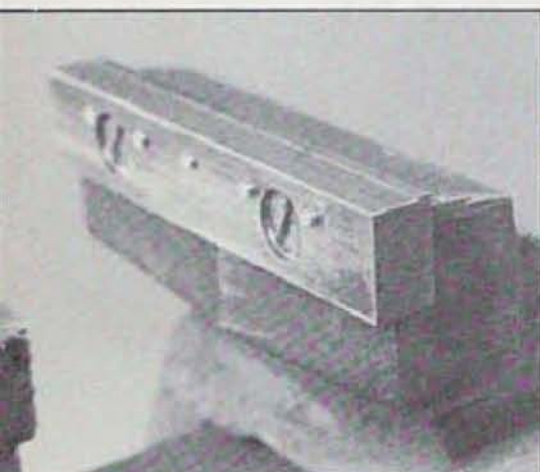
BACK PLATE
BODY



OVERSIZE DETAIL OF PIN.
MAKE FROM BRASS.
WHEN FREE, SPRING SHOULD PUSH PIN
1/16" (1.5mm.) PROUD OF BODY

PINS SHOWN ONLY IN ONE
HOLE MUST BE FITTED
IN ALL FIVE WITH SPRINGS
BEHIND.

©



This picture shows the sprung jaw fitted to the vice; drawings above show clearly how the idea works.

material that is to hand. The base should be at least $\frac{1}{2}$ in., or 12 mm, thick but can be round or rectangular. The one illustrated was a piece from the scrap bin and so has some odd holes drilled in it which are of no consequence. Of course, those who like to make their tools look good will want to use a nice bright piece of mild steel, no doubt with bevelled edges for appearance, and indeed why not!

Whether or not the bottom of the pillar should be permanently fitted to the base is again a matter of personal choice. If it is left so that it will come out, the device is easier to store. The actual pillar is a piece of mild steel, minimum diameter $\frac{1}{2}$ in., or 12mm, and it is drilled and tapped in the lathe to accept the adjusting section which should be about $\frac{1}{2}$ in., or 8mm, diameter and

threaded to allow it to raise and lower in the bottom part of the pillar. A suitable lock-nut ensures the support maintains its position once at the correct height. The support can be either round or rectangular and the one shown is from 1 in. diameter mild steel bar. A slightly larger diameter, say 2 in., or 50mm, would have been an improvement.

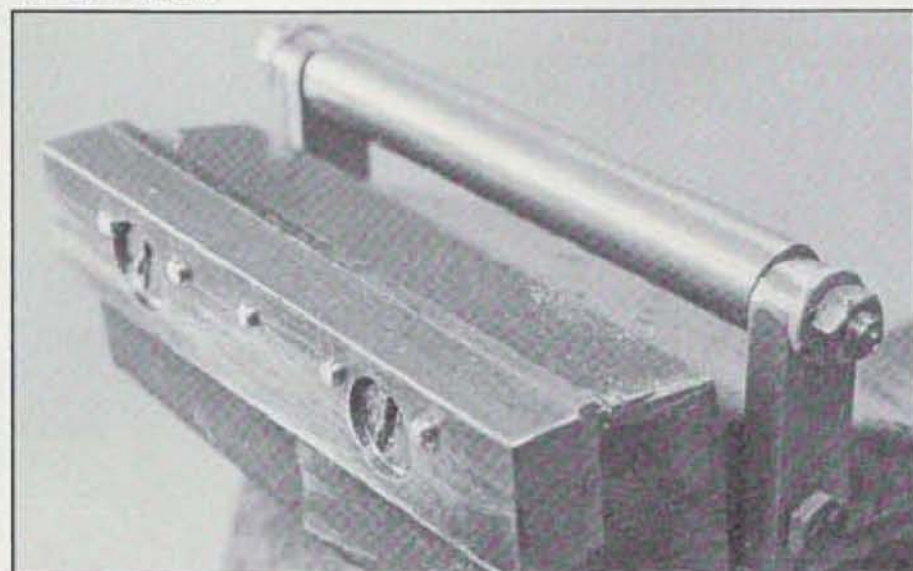
There is another little aid that can be made to fit the vice and this is a special soft jaw that allows work to be adjusted easily. It is screwed in place of the existing hard jaw. Most readers will have had the frustration of trying to get work to the exact height required — to raise or lower it, the tension has to be removed and this usually lets the work slip. Either that or attempts are made to alter the height of the material only to find that the jaws are too tight. It's one of those little problems of life that at the time seem insoluble.

There is no reason why the sprung jaw device should not be used in conjunction with the filing rest.

The special jaw is again ridiculously simple. It is a piece of mild steel drilled to fit the retaining screws for the jaws, to the same measurement as the original jaws, and of a slightly thinner section than the normal jaw. Extra holes are drilled in it and at least three of these are counterbored at the rear — the example shown has five of these holes. Fitted behind is a mild steel plate held in position with countersunk screws which fit into pre-tapped holes in the new jaw. Before assembly, little brass stepped plugs with light springs are fitted in the counterbored holes.

The plugs allow the work to be adjusted as it is held with the spring tension. When the vice is tightened, the plugs recess into the jaw and the pressure goes onto the work.

Here, then, are three little attachments which improve the versatility of your vice and make life easier in general.





**ISN'T IT TIME
YOU TOOK
YOUR HOBBY
SERIOUSLY?**

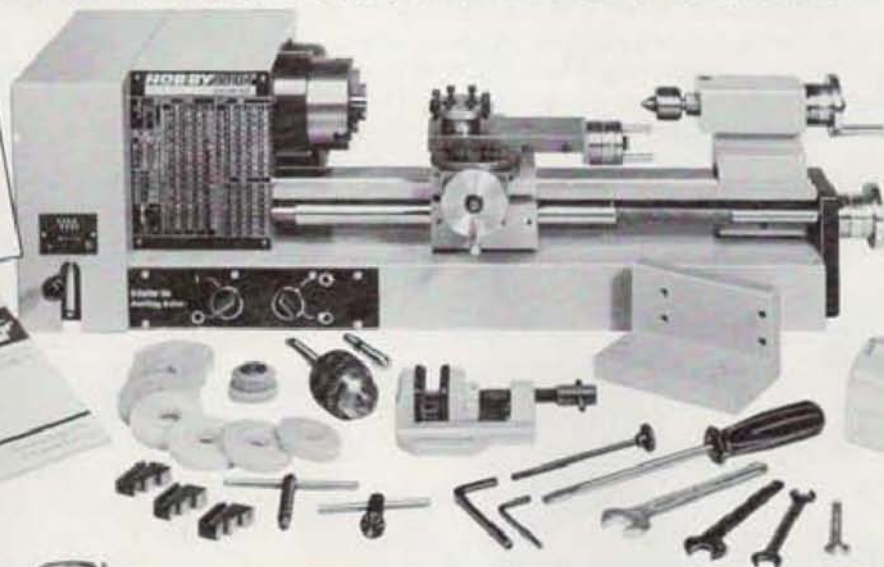


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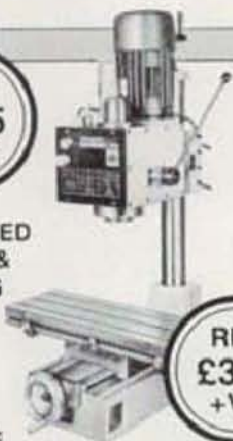
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A R O T A R Y MILLING DEVICE

A rotary table is very useful, but buying one is expensive and making one quite time-consuming. This simple device by Tony Daish enables work to be milled to small radii, and makes the rounding off of coupling rods and similar locomotive parts easy. Even if a rotary table is available there is still a call for a tool such as this in the workshop; its ingenious system of stops will make such work very easy indeed.

When making connecting and coupling rods the need arose for a means of machining the radiused ends. They can, of course, be filed using a guide as I did for valve gear linkages, but I decided that machining would produce a better result, particularly where there were oil boxes. I did not fancy LBSC's method of using a pivot pin in the toolpost for the rod end, which is rotated against an end mill mounted in the headstock chuck.

Consideration was given to making the rotary table to the excellent design of George Thomas, but being a little impatient I decided to design and make my own fixture, with the following points borne in mind:

1. Quick and easy to construct.
2. No 'difficult' machining.
3. Low in height.

Although primarily designed to mount on a Myford vertical slide, it can be used on any milling machine with suitable clamping. If you wish to make one too, here are the drawings and 'how to do it'!

Making a start

Make a start with the base using a mild steel blank. Clean up the edges by milling or filing, then deburr. Mark out the centre and centre punch. Use dividers to mark out

the radius and pitch of the twenty $\frac{1}{16}$ in. dia. holes for the stop pegs, also the four corner holes for cap head screws. Centre punch all hole centres and centre drill. Follow up with the appropriate drills,



Outside rods and valve gear on a 'William' 2-6-2T in 3 1/2 in. gauge by G. Hammond (above); a rotary milling device like that described is ideal for this sort of work.





counterbore for the cap head screws, then ream the $\frac{1}{8}$ in. holes. Deburr all holes.

Mount the base in the four-jaw chuck using outside jaws, interposing packing to save marking the edges of the base. Use a

centre finder to set the central mark to run true. Centre drill, drill and/or bore to $\frac{1}{8}$ in. dia. maximum. Machine the recessed diameters to drawing and skim the bottom face. Then open up the centre hole to 0.745 in. diameter with smooth finish imparted. Deburr all edges.

Reverse the base in the four-jaw chuck, ensuring that it beds down firmly against each jaw to maintain parallel faces. Skim the top face and deburr all edges.

Now for the table

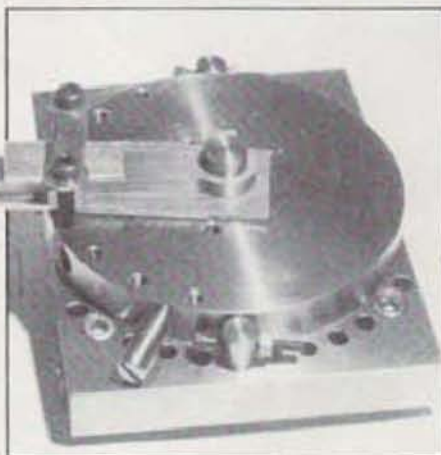
The table is the next item to be tackled. Again a mild steel blank is used. Mount it in the three-jaw chuck using outside jaws, skim the top face, centre drill, drill and/or bore to $\frac{1}{8}$ in. dia., counterbore 0.877 in. dia. by $\frac{1}{8}$ in. deep. Open out the centre hole with a $\frac{1}{8}$ in. reamer or use a boring tool. Put a small chamfer on the counterbored end of the $\frac{1}{8}$ in. hole. Remove from the chuck and put aside for the moment.

Turn the pivot next. After roughing out, turn the $\frac{1}{8}$ in. dia. for $\frac{1}{8}$ in. length under the head to give an interference fit with the hole in the table; plus 0.002 in. should be about right. Relieve the rest of the pivot to 0.749 in. dia.

If you have a substantial bench vice, use it to press the pivot into the table, otherwise resort to the hammer! Put a suitable length of sleeve over the pivot to allow it to be driven home to its shoulder in the counterbore of the table. A little oil on the mating diameters will help.

Now mount the assembled table and pivot in the three-jaw chuck—pivot outermost. Finish turning the pivot, making the journal a close clearance or push fit in the base. Give a skim over the bottom face of the table to ensure it runs true with the pivot. Centre drill the end of the pivot, open up with a $\frac{1}{8}$ in. drill by $\frac{1}{8}$ in. deep, tap $\frac{1}{8}$ in. $\times$ 32 TPI. Drill through and ream or bore $\frac{1}{8}$ in. dia.

Reverse in the chuck ensuring that it is bedded firmly against the jaws. Give a skim



over the top face of the table, which will also bring the end of the pivot flush. Deburr.

Decide if the suggested tapped holes in the top face of the table will meet your requirements for clamping, amend if you wish, then drill and tap. The holes in the periphery of the table are also suggested dimensionally and these can be drilled on the drilling machine using an angle plate or on a vertical slide in the lathe. The centre line of the holes do not have to pass precisely through the centre of the table. Deburr.

The collar, stop pegs, stop pin, handle and plug are simple machining jobs, for which I feel there is no need to go into detail. The tee-nuts are milled to the dimensions shown, then drilled and tapped for the clamping screws.

Opposite page, bottom, plenty of machined details are seen on this pretty 5 1/2 in. gauge 'Polly' by J. Wadsworth. Above, neatly finished coupling rods on Charles Weatherley's LBSC-designed 'Mona' in 3 1/2 in. gauge. Left, the completed rotary milling device.

The table and base are assembled with an anti-seize compound applied to the pivot and underside of the table. Put some of the same compound on the abutment face of the collar and fit it over the pivot.

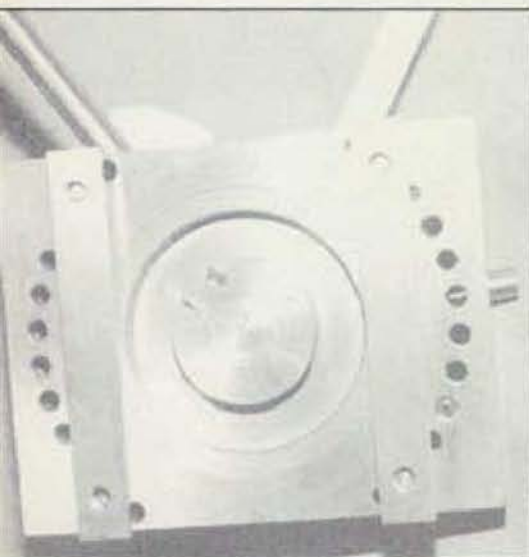
For simplicity I decided not to put threads on the pivot and collar and it has been found that with light taps on the collar to tighten, or light taps on the end of the pivot to loosen, the desired amount of friction is easily achieved. Turn a locating peg to suit the component to be machined, having a diameter of $\frac{1}{8}$ in. to fit the table.

In use

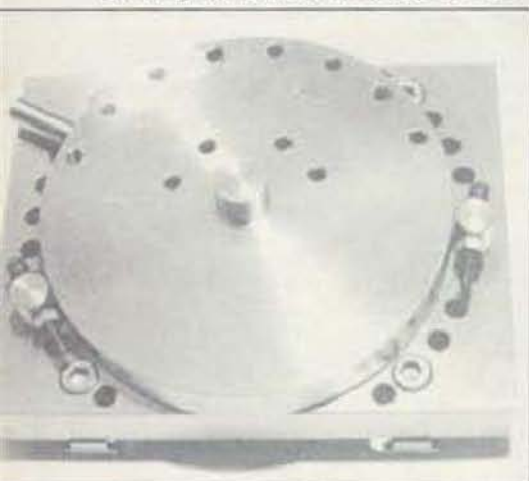
The assembled table can be mounted on the Myford vertical slide in any orientation through 90 deg., as the fixing centres are the same each way. Arrange the stop pegs and adjust the stop screw to give the required amount of rotation. Use the stop pin in the periphery of the table if you are able to use the component to be radiused as a handle, otherwise fit the

Below, ugly but efficient! The works - including the steam reverser linkage - on Harry Paviour's Southern Rly class 1. Q1. A device like ours would have helped here!





The underside of the milling device showing the bearing and long tee nuts.



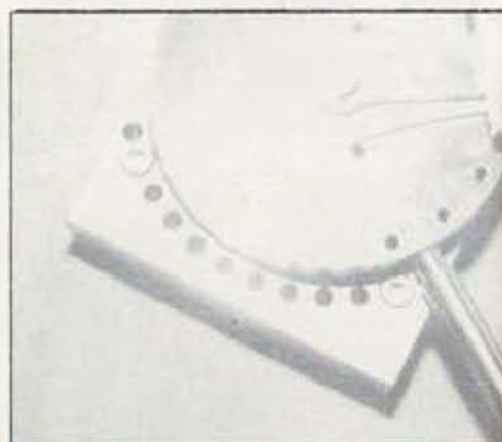
A view of the table without the handle; the photograph clearly shows the arrangements for the stops. Top right, finely milled rods, spring hangers and smokebox door hinge fittings by N. Hitchen on his partly built LNWR 2-4-2T for 5 in. gauge. Next down right, the valve motion components well defined in steel on this 0-6-0T 'Simplex' nearing completion by B. Ellis. Note the milled, curved expansion link. Below, 'Royal Sovereign', a handsome B2 class 4-6-0 by Tony Wall of Leeds, seen in action at the Staines track in 1988.



handle. By arranging the orientation of the base and position of the stop pins an infinitely variable arc may be set up, albeit short of the full 360 deg, but who wants to lop the end off their coupling rods! With safety in mind, arrange for the handle, or rod if used as a handle, to be in front of the milling cutter. It is bad practice for one's hand to go behind the cutter, so do take

care —no loose clothing, etc. Don't forget to interpose a piece of material between the component and the table face to allow the milling cutter to cut just beyond the component, but not into the table face.

I have been pleased with the



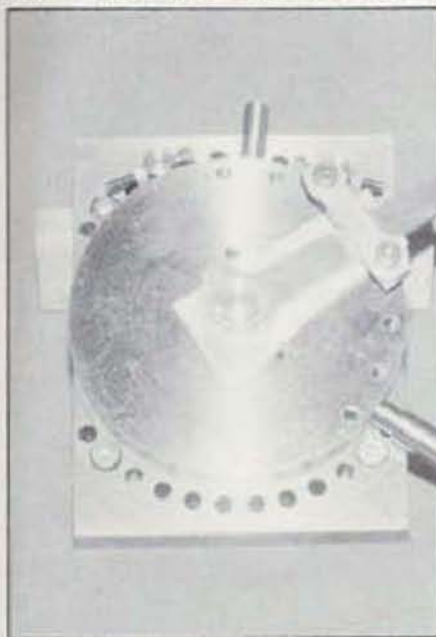
A close-up view of a coupling rod held on the device for machining. Note the thin sheet alloy underneath to protect the tool from damage as the cutter breaks through.

effectiveness of the fixture for radiusing the ends of rods, such that I put it to another use, which was to radius die blocks to fit the curved slots in expansion links. For this a bar was drilled and reamed for a $\frac{1}{2}$ in. dia. dowel and at the radius the same as the expansion link slot centre line, a hole was drilled to suit the diameter of the die block pivot. A vertical slide was mounted horizontally on a large angle plate and with the aforementioned bar clamped to the fixture table and mounted on the slide, the height of the slide was adjusted so that the

bar just rested on the top of the angle plate to give support.

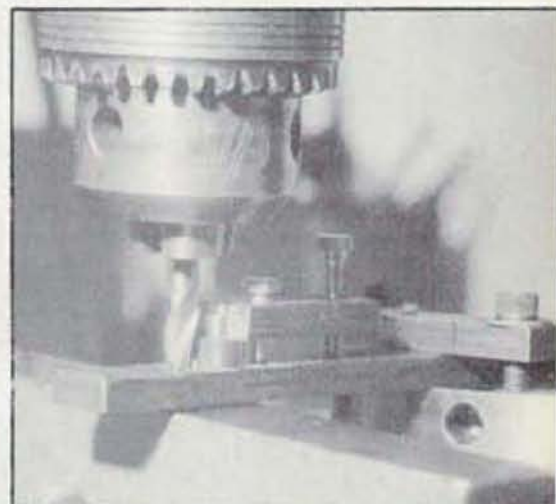
This was set up on my drilling machine.

Below left, this overhead view shows the connecting rod in position and how the handle is used separately as a means of controlling the table. Some previous devices have actually used the component being machined to swivel the table. Below, alternative arrangement for the stops with a split collar which expands in a plain hole rather than the original idea of screwing the stops into position.



Although designed primarily for making parts for model locomotives, the rotary device could be used equally successfully for machining parts for a whole range of models - like this fine traction engine, perhaps...

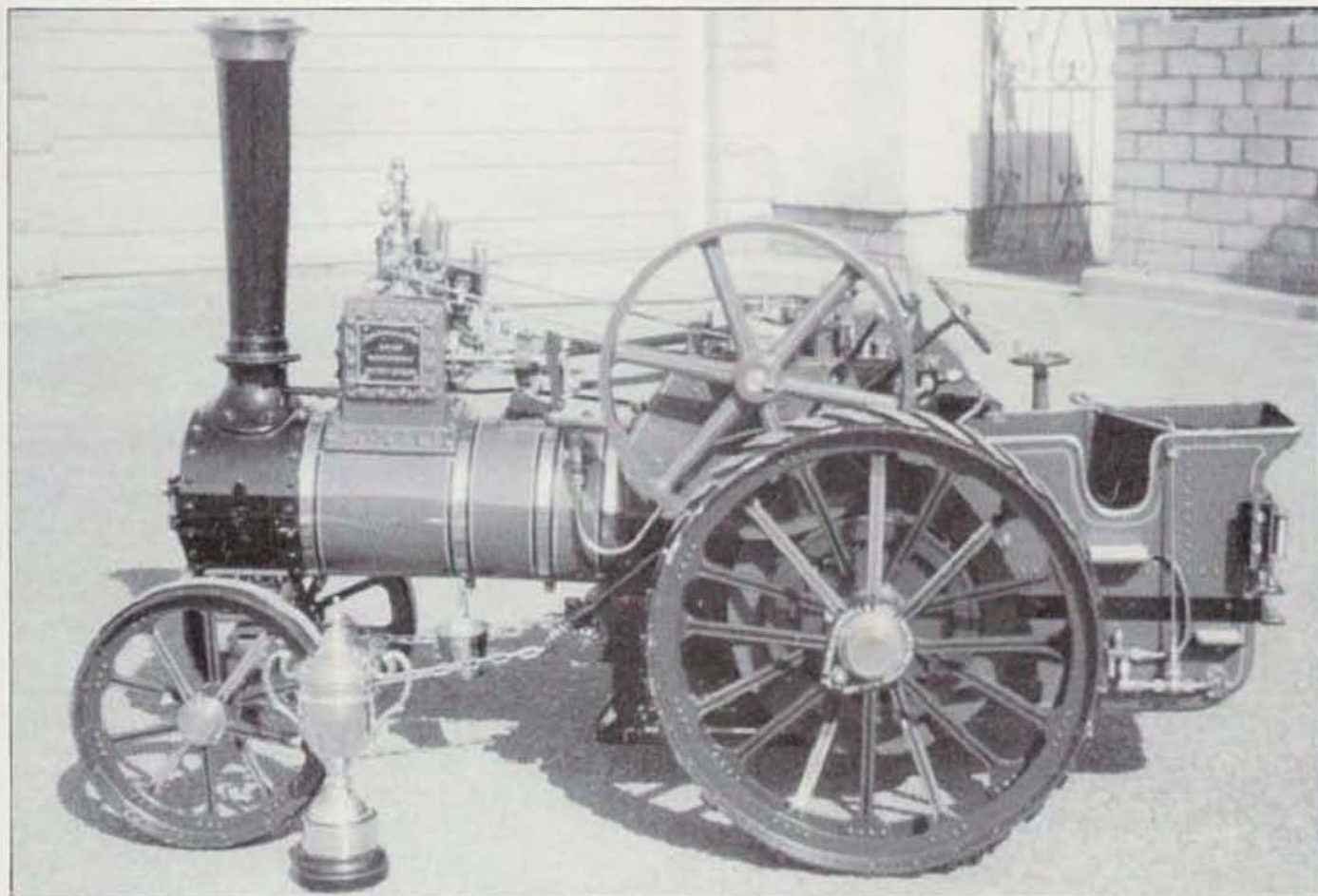
(modified with a large angular contact bearing in a housing on the bottom of the quill in place of the original smaller bearing, so that I would be able to carry out light milling). By calculation, the required amount was machined off to give the inner and outer radii. Incidentally, the die block



Here the device is used at the opposite end to mill an expansion link slot. Note that there must be support underneath to prevent vibration. In this case the edge of the angle plate is pressed into service.

was clamped to the bar with alternate inner and outer clamps, fitting the second one before the first was removed.

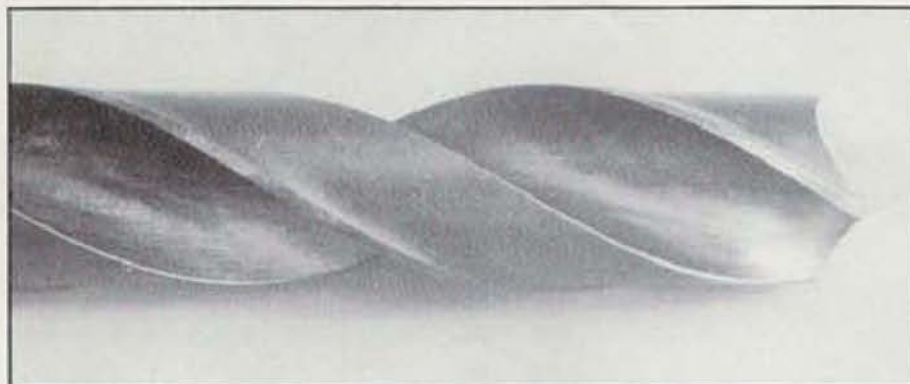
I might add that this fixture was not intended to obviate the need for a worm driven, graduated rotary table, one of which I have since acquired.



USING & CARING

T W I S T D R I L

The lowly twist drill comes in for its fair share of abuse around the workshop. Here's how it should be used and looked after!



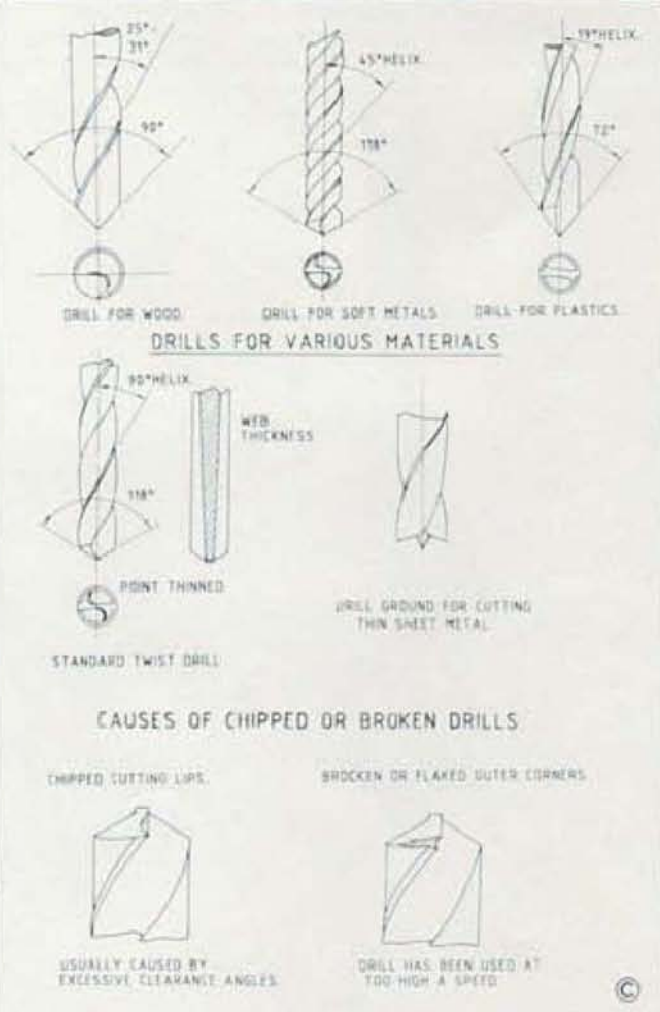
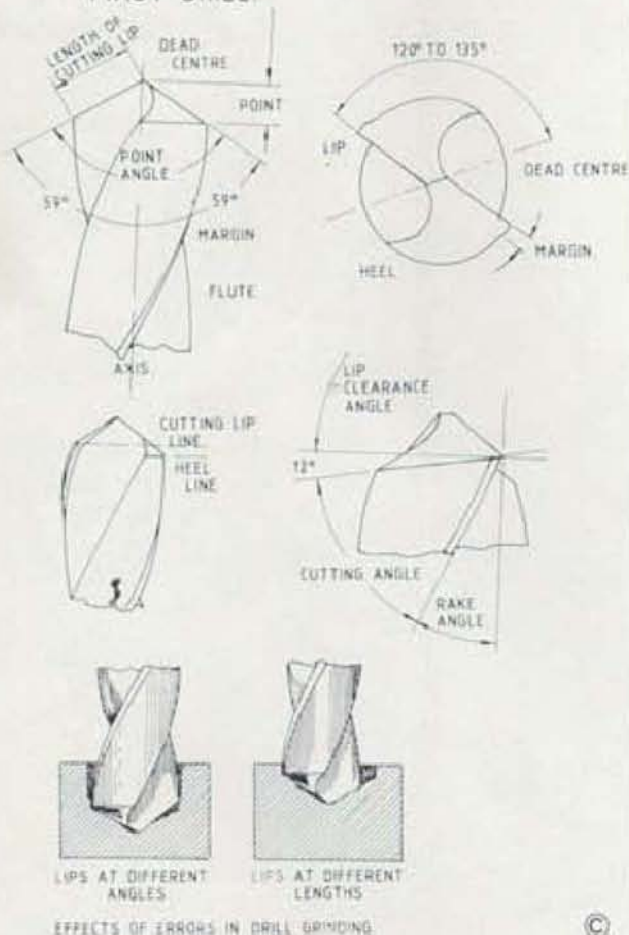
This picture clearly shows the correct point and clearance angle for a normal twist drill; note the difference between the cutting edge and the clearance angle which can be seen clearly.

One of the most familiar tools in the workshop is the twist drill. It is sometimes called the *drill bit*, and on other occasions just plainly a *drill*, and just to confuse things it may also be known as the *Jobber's Drill*. Whilst the latter descriptions are perfectly accurate they do not differentiate between the twist drill and other types of drilling device, of which there are quite a few. However, the purpose of this article is to explain the construction and care of the twist drill rather than to survey drills in general.

Drill nomenclature

I am quite sure that there is no need to explain to readers what is meant by a twist drill; the suggestion that it is just a twisted piece of metal may seem somewhat strange and in fact is not entirely true as these days drills are completely machined. However, it is not very long ago that small diameter drills were described as *wire drills*

SHAPE & ANGLES OF A STANDARD TWIST DRILL



FOR L L S

because they were, more or less, twisted wire.

Most drills that the home workshop enthusiast will be concerned with are made from high-speed steel. This is a special steel that will be dealt with in detail at a later date but suffice to say that it is a particularly suitable material for our purpose being very tough and not normally softened under heat. It is not often that twist drills made from carbon steel come our way these days but if working with metal they are best avoided although they can be used where the drilling of wood is concerned.

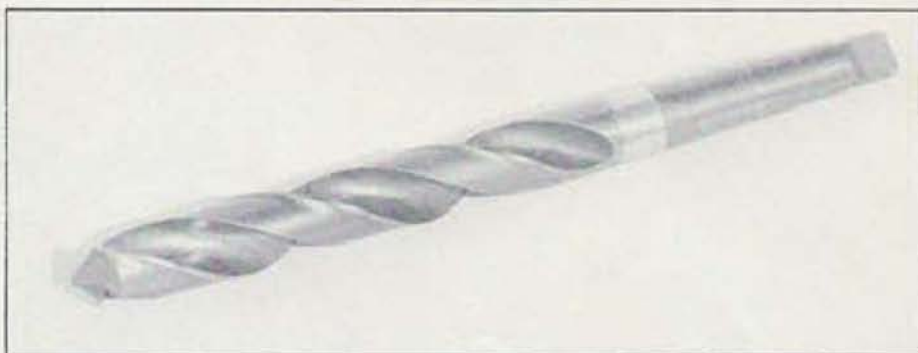
Whilst we do not need to take a degree in the subject, some knowledge of the format of twist drills will be an advantage in our hobby. The outside edge which is twisted along the length of the drill is known as the *helix*, and this is normally at an angle of thirty degrees, which is suitable for most purposes. Drills for plastic, however, should have a helix angle of nineteen degrees, for wood twenty five degrees and for drilling softer metals such as copper the angle should be forty five degrees. Now if only a small number of holes are to be drilled in a particular material it is hardly worthwhile buying a special drill and so the normal thirty degree helix type will almost certainly have to do all the work.

The helix is the part of the drill that throws the waste material (or swarf in the case of metal) away from the work. The different helix angles cope best with the various materials. For example, if we look at the forty five degree helix drill it will become obvious that this is taking the swarf out faster than the one of 30 degrees and so on.

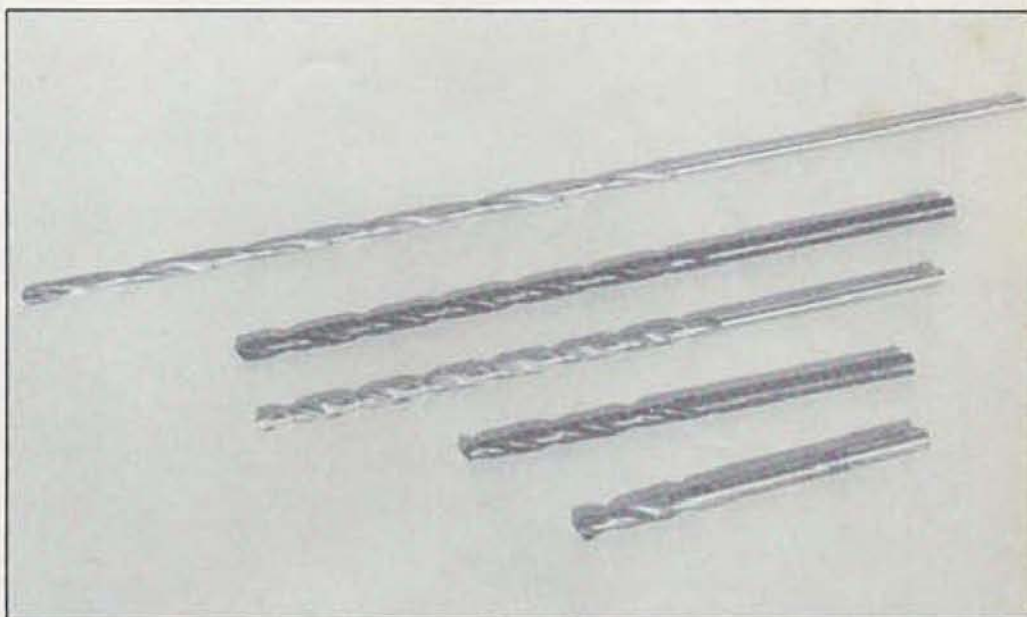
The solid metal running up the centre of the drill is called the *web* and it is this which gives the drill its strength. Normally the web is thinner at the cutting point than it is near the shank, the thickening being a gradual process. Where drills are intended for softer materials the web may well be of a thinner section as less strength is required. This has the advantage that a larger gap is created between the helixes and so waste material is removed quicker.

We will be coming to the sharpening of drills but it now becomes obvious that the more a drill is ground to sharpen it the thicker the web becomes at the point. This in turn creates a thicker point, making it difficult to start the hole, and so from time to time the web must be thinned down. In particular, if a broken drill is reground the web will definitely need to be thinned in order that the drilling operation can be accurately started.

The *shank* of a twist drill will vary according to the size of the drill to a large extent. Frequently we get very small



A typical large sized twist drill with Morse Taper shank for fitting directly into the drilling machine or lathe.



This picture shows a small selection of drills available. At the bottom is a stub drill from tungsten, ground with a slightly flatter than usual point and used for drilling hard material where the shorter length gives greater rigidity. The drill above it is a standard twist drill, then comes a long series drill with a slightly quicker helix for use on softer materials and, above that, a standard long series drill. At the top of the photograph is an extra long series drill designed for use on plastics. All the drills shown are of 1/4 in. diameter.

diameter drills which have a larger diameter shank. The reason for this is fairly obvious – it is easier to grip the larger diameter shank in the chuck. Normally the shank will be straight and will reflect accurately the diameter of the drill. Larger drills will usually have Morse Taper shanks and will fit either directly into the drilling machine or the lathe. Occasionally we will find a drill with a reduced diameter shank; mainly such drills are designed for the Do-It-Yourself market these days but at one time were greatly favoured by blacksmiths and, in fact, came to be known as blacksmith's drills. The disadvantage of the smaller diameter shank is that there is less metal to get a grip on and the drill is therefore more likely to spin in the chuck and get damaged.

The Business-end

Let us now get to the business-end of the twist drill. At first glance the shape is not all that obvious, it just looks as though there is a point on the drill and that is all. In fact not only is the point at a critical angle but there is also a clearance angle to allow the drill to cut and the swarf to be released. If this clearance was not there the drill would rub its way through the work rather than cut and would, in so doing, generate a

great deal of heat. On larger diameter drills there is a cutting angle as well as the clearance. This too aids cutting and prevents heat build-up. When we get to very small sizes this becomes less obvious, the cutting and clearance angles doing the same job. The faces on which these two angles occur are called the *lips*.

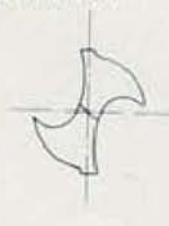
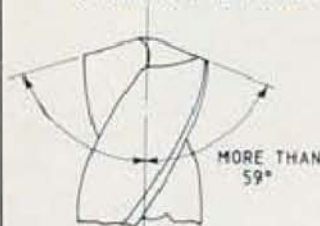
For all normal work the point angle of our twist drill will be fifty nine degrees or an included angle (both sides) of one hundred and eighteen degrees. For some other types of material this angle can be varied with good effect, basically the rule is the harder the material the shallower the point and more acute angles are used for softer materials.

When thin sheet has to be drilled the angle of the point must literally be reversed and become negative or the drill will snatch as it breaks through the metal and a screwing effect takes place. What is needed then is to get the outside of the cutting edges through the material before the point and this will then obviate the problem. It is quite possible to reground a drill suitably for such work but if only one hole or so is required this can be an expensive proposition. There are alternatives.

For larger diameter holes it is quite possible to use one of the flat spade drills

FAULTS IN DRILL GRINDING

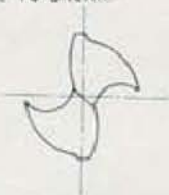
POINT ANGLE TOO OBTUSE MAKES IT DIFFICULT TO START HOLES AND CAUSE OVERHEATING



CORRECT WEB THINNING



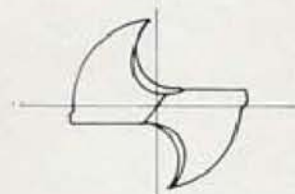
POINT ANGLE TOO ACUTE WEAKENS DRILL POINT & MAKES IT LIABLE TO BREAK



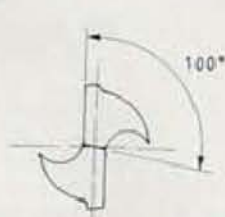
EXCESSIVE WEB THINNING WEAKENS POINT



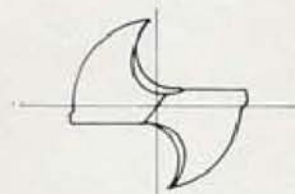
POINT ANGLE UNEQUALLY DISPOSED ABOUT DRILL AXIS WILL CAUSE OVERSIZE HOLE



EFFECT OF INSUFFICIENT CLEARANCES DRILL WILL RUB & OVERHEAT



UNEVEN WEB THINNING CAUSES HOLES TO BE OVAL



sold for use with portable electric drills. These are made of high speed steel and cut thin metal very nicely. Drills of this type can be made from silver steel where they are intended for limited use. An alternative is to line up the drill point with the hole position and clamp the work down. Lay a piece of emery cloth over the hole position and drill through the cloth and the metal – the emery cloth preventing the drill from screwing up the metal.

When drilling brass, copper and bronze the drill is liable to snatch when it breaks through the metal. To avoid this the cutting edges should be just blunted slightly with a small oil stone.

The use of a proper drill grinding jig is essential if accuracy is to be maintained and even then it is possible to grind the drill so that the point is off centre if care is not taken. If the drill has to be hand held during grinding operations then it should be brought to the rotating grindstone at the required angle and when in contact gently rocked to obtain the clearance angle. Drills should always be ground on the periphery of the grindstone; grinding on the side is dangerous as the stone can be damaged and break up during use.

Gauges

It is worthwhile making up a gauge to check drill angles to ensure that they are correct. This need only be a piece of sheet metal with the angle filed on one end. A gauge to ensure that both sides are ground evenly is also very useful. At first glance this does not sound quite so easy to arrange as the length of the points will depend entirely on the drill diameter. A simple arrangement is to bend a piece of sheet metal to an angle and make a recess for the drill to slip into. If the drill is drawn across the upright it will make a mark at the edge of the lip. The aim is to get both sides to mark the same spot exactly. The one trouble with this arrangement is that in no time at all the upright is so covered in marks that it is difficult to see which is which! It is therefore as well to put a loose piece over the upright which can be changed when it has seen better days. Alternatively, stick a piece of thin card such as postcard on the upright and change it frequently.

Sometimes drills can be modified for special work, for example the drilling of thin section material and the point angle altered as need be for the material involved.

Faulty grinding of drills will cause problems when they are used. If the angles are unequal, for example, the drill will tend to push sideways in the metal and not only cause the hole to be out of position but also cause it to be slightly oversize. Equal angles but of differing lengths will cause the same difficulties. Incorrect clearance angles on the point will cause rubbing if the angle is too shallow, and the drill will be inclined to break if the angle is too sharp. The reason for the latter is that the cutting edge digs into the metal and there is no metal behind to support it because of the shallow angle.

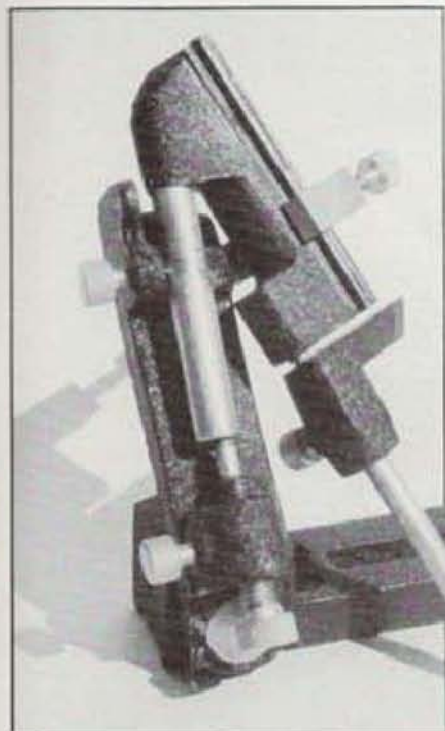
Long lengths of swarf are dangerous and therefore larger drills may be ground with a couple of tiny notches on the lips. This will break the chips up as they come from the metal. It is sometimes possible to purchase larger diameter drills already ground in this fashion.



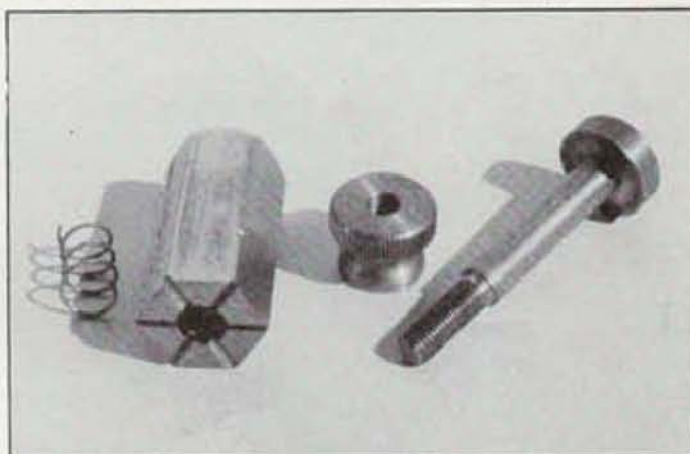
As an illustration of how special drills are available if required, here's a $\frac{1}{4}$ in. diameter one over 12 inches long. Wandering off line is almost inevitable during the making of a long hole with a normally ground drill. To obviate this, this one has a specially designed double angled cutting edge which acts both as a centre and a cutter and keeps the drill in line over long distances.

USING & CARING FOR TWIST DRILLS

Very small drills may be sharpened with an oil stone or on emery cloth. Grinding them will take off far too much metal and also cause overheating and ruin the temper of the drill. Overheating when sharpening drills is to be avoided at all costs and the practice of dipping hot drills in water is not to be encouraged as it can cause brittleness. The overheating should be avoided in the first place.



Left, a drill grinding jig is something which should always be used when grinding twist drills in order to ensure that the correct angle is obtained. This one will hold a range of drills from $\frac{1}{8}$ in. to $\frac{1}{2}$ in. diameter. Above left, this simple jig for sharpening very tiny drills on emery paper has been published in Model Engineer magazine on a number of occasions. Above right, the main body of the jig is a piece of hexagon bar drilled right through and counterbored at one end. Square bar has also been used with success. Below, the other end of the bar is grooved to accept the drills which pass through a hole in the securing screw. The spring goes in the counterbore of the body and the drill is held tight by the knurled nut. In use, the drill is simply lined up and rubbed flat on emery paper or oilstone then turned through one hundred and eighty degrees and the operation repeated.



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A POWER HACKSAW

Hacksawing of metal by hand can be both time-consuming and very hard work. There have been many power hacksaw designs described over the years. This one by John Brittain is made from stock materials and some welding is involved, although no doubt other methods of construction could be employed. A right-angle drive geared motor supplies the power. It is unlikely that readers will be able to obtain the same motor and gearbox but there are suitable ones on the market, often as second-hand or surplus bargains — worth looking for and freely available is the Parvalux. One particular asset of this design is the use of a dash pot; this relieves the strain on the blade on the return stroke and makes for a smooth-running piece of equipment.



Bracket which supports the motor. Readers will probably need to modify this in detail to suit their particular motor.

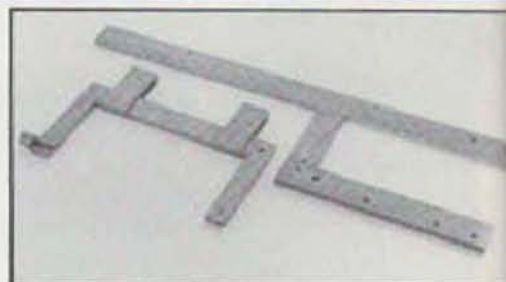
It all began with a visit to a car boot sale. Like many others who believe that one man's rubbish can be another's treasure, I enjoy browsing round such places where I frequently pick up the odd item for the workshop. On one such occasion, I happened to spy the rear end of an electric motor sticking out from beneath a pile of 'goods'; further examination revealed that the other end possessed a worm gearbox, which immediately prompted the thought 'power hacksaw.'

The princely sum of £1.50 changed hands and I bore my new acquisition home where I was able to check it in more detail. Alas, the awful truth was revealed for, not only did the motor need 110 volts to drive it but, upon checking the stator windings, I found that one of them was 'blown.' Consoling myself with the thought that 'you can't win 'em all', I hove the offending article into the back of the garage and forgot about it.

Some months later, I was rooting about amongst my accumulated junk when I unearthed an electric motor which I had 'put into store' some ten years earlier and which now reminded me of my unfortunate purchase. An idle thought flitted through

my mind. 'I wonder whether the bolt holes of the two motors happen to coincide?' A quick check with a pair of dividers indicated that indeed they appeared to do so and I was galvanised into renewed enthusiasm. Taking the two motors to the workshop, I confirmed that the bolt hole centres were a perfect match and began to work out how the pair could be combined so as to form a single 240 volt unit with gearbox attached. After due cogitation and an examination of the sizes involved, I decided that it might be possible to remove the worm from the gearbox motor, mount it on the shaft of the other one and thus marry the two units together.

As far as I could ascertain, apart from minor modifications to the gearbox motor casing in order to accommodate the second one within it, the only other alteration necessary was to provide longer studs with which to bolt the two items together. However, by far the most taxing problem concerned the worm, which was integral with the rotor shaft and, as



The 'H' frame and saw frame. Parts here are welded but could be silver soldered, brazed or, with adaptation, bolted together.

expected, found to be dead hard! How far down the shaft did the hardness extend? That was the question. I tested it with a file and was relieved to find that the portion needing to be bored appeared unhardened. I cut off an appropriate length of shaft, complete with worm and ballrace and, chucking it very carefully in the lathe, prepared to drill and bore. Half an hour later, after making haste very slowly (no second chance in cases like this) I had obtained a tight push fit on the shaft of the second motor and was gratified to note that, upon testing, the worm ran truly. A pair of grub screws tightened on to the flat of the motor shaft secured the worm in position after which, once the stator windings had been removed from the gearbox motor, the two 'halves' could be fitted together.

This was accomplished surprisingly quickly and so easily that I began to suffer from that feeling of impending disaster which I'm sure we all experience from time to time when things are going just too well — but no, Lady Luck was well and truly on my side this time and I completed the assembly without mishap. Upon switching on for the first time and seeing the motor whirring away happily with the gearbox shaft turning in silent unison, I indulged myself in a few moments of quiet satisfaction before turning to the question of the hacksaw design.

The mounting for the original motor was in the vertical plane and consisted of a sturdy bracket fixed to the side of the gearbox. I felt therefore that there was little point in altering the arrangement and concluded after some thought that this

DIAGRAM 1

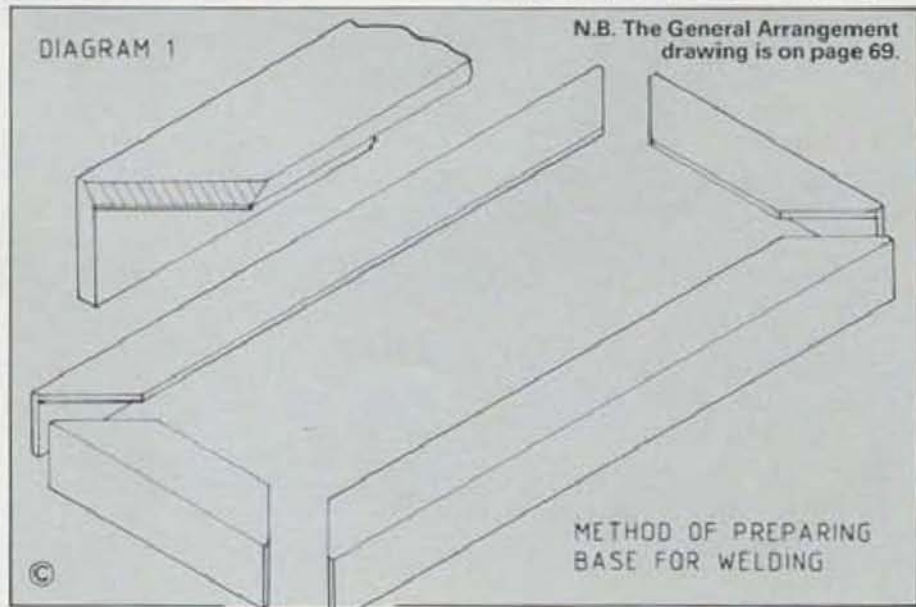
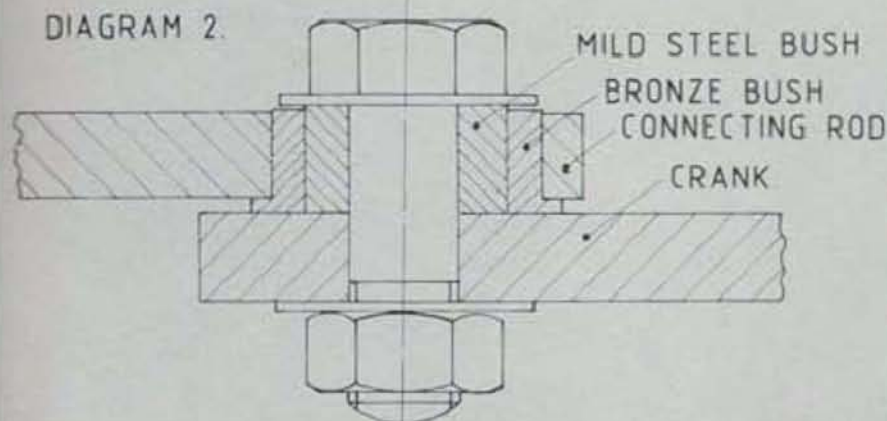


DIAGRAM 2.



each mitre in the centre to hold the joint temporarily before turning the whole thing over and welding all the joints, first the mitres and then the corners. For those unfamiliar with the technique, this is a very good method of constructing a frame from angle iron and results in a job which is well-nigh indestructible and which has many obvious applications.

This done, I welded a cross-member part-way along and flush with the top edge of the frame, the main purpose of this piece being to support the vice runners. These two items were soon welded into position, after which I turned my attention to the pivot shaft and bushes. The shaft was turned from $\frac{1}{2}$ in. diameter bright mild steel, shouldered at both ends and threaded $\frac{1}{2}$ in. B.S.W. ready to be bolted to the 'H' frame. The bushes were turned from $1\frac{1}{2}$ in. diameter B.M.S. and bored to fit the pivot shaft. They were then slid on the shaft and clamped at their correct location before being welded in position at the end of the base.

'H' frame

The 'H' frame was next on the list and this was constructed from $1\frac{1}{2}$ in. $\times$ $\frac{1}{2}$ in. B.M.S. Now the side surfaces of this component needed to lie in the same plane if the machine was to be expected to work accurately and I was mindful of the distortion which would probably take place whilst the welds were cooling and shrinking. To minimise this, I first tack-welded each joint, turned the whole thing over, ran both welds and then turned it again quickly in order to complete the welds on the first side before too much cooling had taken place. I then waited until the job had become completely cold before inspecting for accuracy. Inevitably there was a small deviation from the truth but the judicious use of a large hammer, a block of wood and a blacksmith's vice straightened matters! Not exactly precision engineering but nevertheless quite effective in this case.

Saw frame

The saw frame came next and here again I employed welding as a means of joining the three main components together. However, the 'keep' plates were assembled by a different process. I first positioned a pair of 2 in. $\times$ $\frac{1}{2}$ in. B.M.S. pieces on the frame, held them in place with toolmakers' clamps, drilled and riveted them with $\frac{1}{4}$ in. dia. countersunk rivets. Having fixed the second pair likewise, I then slid the 'H' frame between both pairs before positioning 2 in. pieces of $\frac{1}{2}$ in. square bright mild steel between their top edges which were protruding above the frame. Again, holding these pieces in place with clamps, I drilled right through each in turn, countersunk and riveted (after first removing the 'H' frame). A little careful draw-filing on the 'H' frame produced a smooth sliding fit between the two components.

Crank and connecting rod

When I obtained it, the gearbox drive shaft held two sprockets which I removed,

a piece of veneered chipboard before settling for a design which allowed the gearbox to overhang the end of the base. Having always admired the extremely neat and compact Westbury hacksaw, I was reluctant to face my gearbox 'outwards' but concluded that I must do so after giving due thought to the disposition of all components.

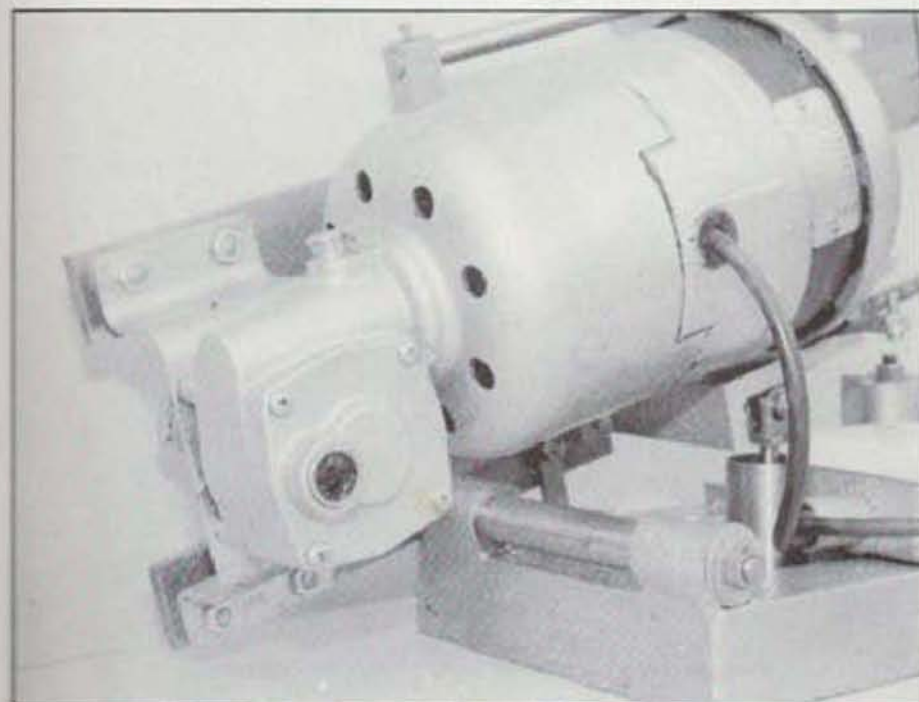
Base construction

Since the obvious method of joining the 'H' frame would be by electric arc welding, I determined that, wherever practicable, I would use this form of construction throughout the project. I had access to a quantity of black mild steel angle which had seen service in a number of jobs and contained quite a selection of assorted holes. However, by picking my way between them, I managed to obtain enough material from which to construct the base and made a start on this item by first cutting the four pieces to length and then cutting the corners off at 45 degrees. I then prepared each 'mitred' edge for welding by filing a generous bevel (see Diagram 1). I laid out the four pieces upside down on a flat surface, 'spotted'

The assembled base. As noted, it may be necessary to modify yours slightly to fit whichever motor and gearbox is used.

feature should ultimately dictate the principle upon which the whole design relied. Accordingly, I decided that the main frame should take the form of a letter 'H', so that the two parallel arms could carry the motor at one end and the other end be used to mount the saw frame.

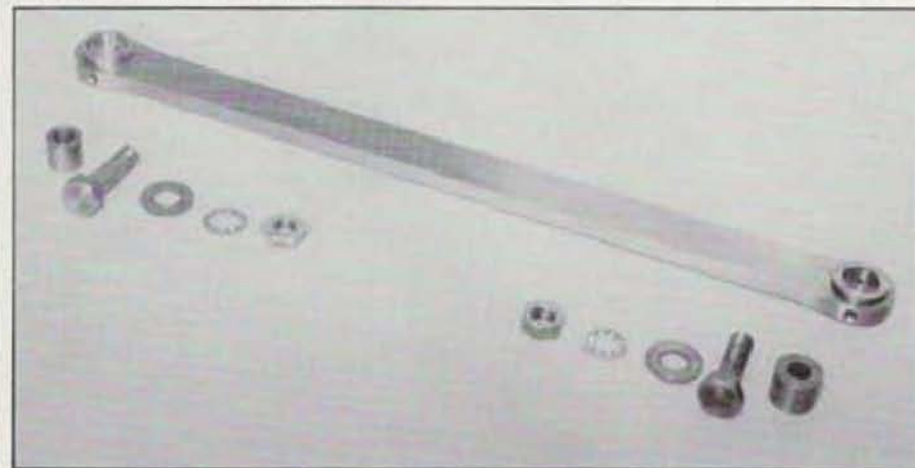
A shouldered shaft, bolted to the lower edge of this 'H' frame could then be employed to pivot the frame on the base. I drew out several full-size arrangements on



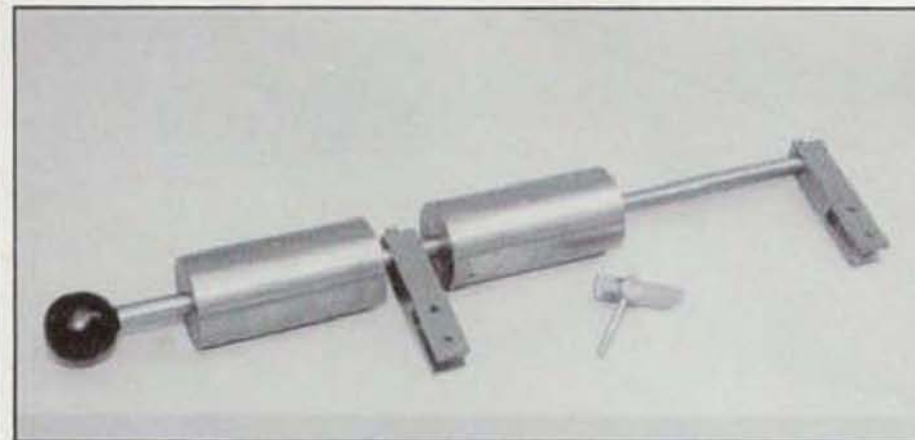
A close-up study of the swivelling arrangement for the motor and gearbox.

leaving a $\frac{1}{2}$ in. dia. shaft some 4 in. long. After shortening this, I bored a 2 in. length of 1 in. diameter bright mild steel (B.M.S.) to be a tight fit on it and formed a crank by silver soldering a piece of 1 in. $\frac{1}{2}$ in. bright mild steel across one end of the bush. I was thus able to utilize the same method of fixing the crank to the shaft as was used to hold the original sprockets in position and, in fact, used the same pin and hole through the shaft. To ensure accuracy of this component, a $\frac{1}{2}$ in. diameter stub mandrel was turned to mount it on whilst taking a light facing cut over the outer surface of the crank.

The connecting rod was made from 1 in. $\times \frac{1}{2}$ in. bright mild steel, being clamped squarely under the toolpost whilst being bored for its phosphor bronze bushes. Since I had the use of a horizontal milling machine, I used this to reduce the width between big and little ends before completing the shaping by filing. The flanged bushes were a straightforward turning and boring job and made to be press fits in the connecting rod. I decided to dispense with the usual form of crankpin in favour of using a plain mild steel bush which was made three or four thousandths of an inch longer than its mating bronze bush and used in conjunction with a bolt, nut and washer to retain the connecting rod assembly in position. (See **Diagram 2**.)



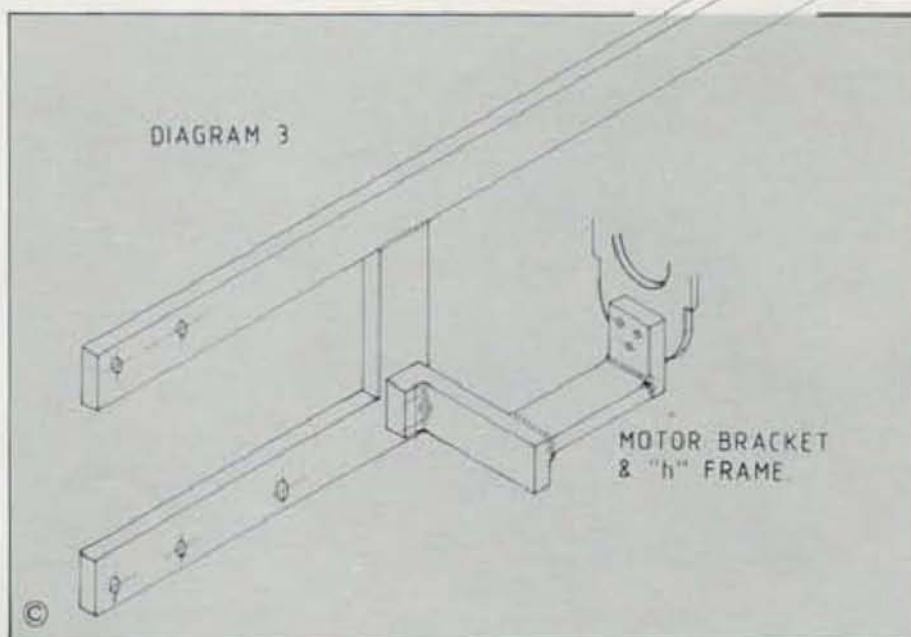
The connecting rod which controls the operation of the saw, together with its bushes.



Counterbalance arm and weights. With any alteration to the basic design, some further slight adjustment may be needed here in order to achieve smooth operation.

Motor bracket

The obvious means of supporting the other end of the motor was by using the resilient mounting. Accordingly, a bracket



was welded together from pieces of 1 in. $\times \frac{1}{2}$ in. B.M.S. in a configuration which allowed it to be bolted to the inside of the 'H' frame and be positioned centrally beneath the motor where the motor support plate could be fixed to it. (See **Diagram 3**.) I also had in

incorporate this feature since lack of space appeared to preclude it.

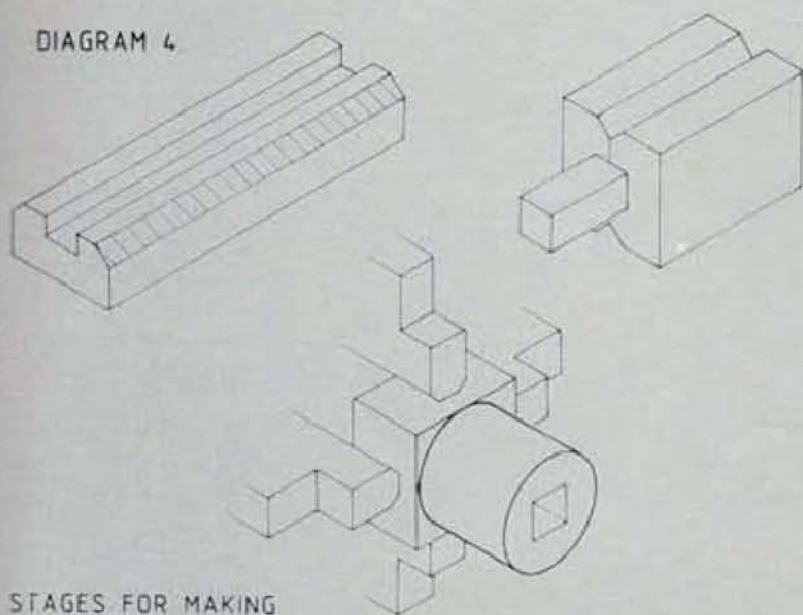
Blade fittings

A 4 in. long piece of $\frac{1}{2}$ in. $\times \frac{1}{2}$ in. B.M.S. was milled down the centre for a depth of $\frac{1}{2}$ in. with a $\frac{1}{2}$ in. dia. cutter and then bevelled generously on its two outside edges adjacent to the groove. (See **Diagram 4**.) The piece was then sawn in two and the two halves held together in a vice ready for welding; a scrap piece of $\frac{1}{2}$ in. square B.M.S. was used to locate the two halves. After welding the 'Vees' formed by the bevelling, the now $\frac{1}{2}$ in. square component was placed for half its length in a four-jaw chuck, set to run truly by the $\frac{1}{2}$ in. square scrap and turned down until no evidence of the flat sides remained. A $\frac{1}{2}$ in. length of this turned portion was parted off and I was now in possession of a neat little cylinder with an accurate square hole running down its centre. Again, for those not so familiar with welding, where applicable, this technique can be recommended as being splendidly quick and, of course, far superior to any attempts at forming square holes from round ones with a file.

One of the saw frame ends was placed in the milling machine and a $\frac{1}{2}$ in. $\times \frac{1}{2}$ in. groove cut across it near the end, after which the aforementioned cylinder was clamped on the outer edge of the frame with the square hole located in relation to the groove in the frame by means of the same piece of $\frac{1}{2}$ in. square material. A quick blast with the welding rod and the two items were fixed firmly together and ready for the blade tightener. This last consisted of a 2 in. length of $\frac{1}{2}$ in. B.M.S. (the same piece which had done all the locating) and milled for half its thickness for a distance of $\frac{1}{2}$ in. It was then placed in a four-jaw chuck and the other end turned for a length of 1 in. to a diameter of $\frac{1}{2}$ in. (or until the flats just disappeared). A $\frac{1}{2}$ in. B.S.W. thread was run on as far as it would go, after which an $\frac{1}{2}$ in. diameter hole was drilled in the centre of the milled portion. I countersank this hole lightly on the milled side so as NOT to leave a fillet of silver solder (the blade would waggle about on this) before soldering a 2 in. piece of $\frac{1}{2}$ in. diameter B.M.S. rod in it. I then bent the rod 'inwards'

mind that, should I fit a dashpot, this bracket might also serve as an anchor point for the piston rod. At the time however, I was doubtful whether I would be able to

DIAGRAM 4



STAGES FOR MAKING CYLINDER FOR BLADE TENSIONER

©



The parts for the vice; it can be used to cut metal at angles other than right-angles.

slightly so as to form a hook, which would tend to make the blade seat firmly against the milled surface when tightened. After bending, the rod was cut off to final length.

Wing nut

For this item, I adopted my standard procedure for making wing nuts, which is as follows:

Taper turn a 2 in. long piece of $\frac{1}{2}$ in. diameter B.M.S. for a length of $\frac{1}{2}$ in. or so. Clamp squarely under the toolpost and slit centrally with an $\frac{1}{8}$ in. slitting saw to the depth of the taper. (See Diagram 5.) Strike a $\frac{1}{4}$ in. radius semicircle on a piece of $\frac{1}{2}$ in. B.M.S., cut out and file to shape. Assemble the two pieces (making sure that they are an easy fit or the solder won't penetrate) flux and silver solder. Check that the solder has run right through the joint on both sides. Shape the wings by first filing a semi-circular depression in the centre and then shaping the ends; final shape is obviously dictated by personal taste. Grip

chucking piece in three-jaw, centre drill, drill and tap ($\frac{1}{4}$ B.S.W. in this case). Part off at base of taper.

Vice

The vice jaws were made from 4 in. lengths of 2 in. $\times$ 2 in. $\times$ $\frac{1}{2}$ in. black mild steel

angle. A $\frac{1}{2}$ in. piece of 1 in. diameter B.M.S. which had been axially drilled $\frac{1}{2}$ in. diameter was then welded in a central position on each jaw and the $\frac{1}{2}$ in. diameter hole continued right through. Pieces of 1 in. $\times$ 1 in. $\times$ $\frac{1}{2}$ in. B.M.S. were drilled through the centre and welded to the heads of a couple of 3 in. $\times$ $\frac{1}{2}$ in. diameter coach bolts (with the square bit under the head removed). These were then used to bolt the jaws to the runners, the square 'heads' being necessary in order to locate against the base edge to prevent turning.

The vice screw was rescued from a long-since discarded woodworker's vice and, after suitable titivation including re-screwcutting the thread and turning the end to an included angle of 90 degrees, was matched with a new nut. I provided a shoulder on the nut and made it a press fit in a 4 in. length of $\frac{1}{2}$ in. $\times$ $\frac{1}{2}$ in. B.M.S. which had been bored to receive it and filed concentrically semicircular with the hole. This component was then welded in position on the end of the base in the centre of the runners. The conical end of the screw was used to mark a position on the nearer vice jaw which was then countersunk to receive it.

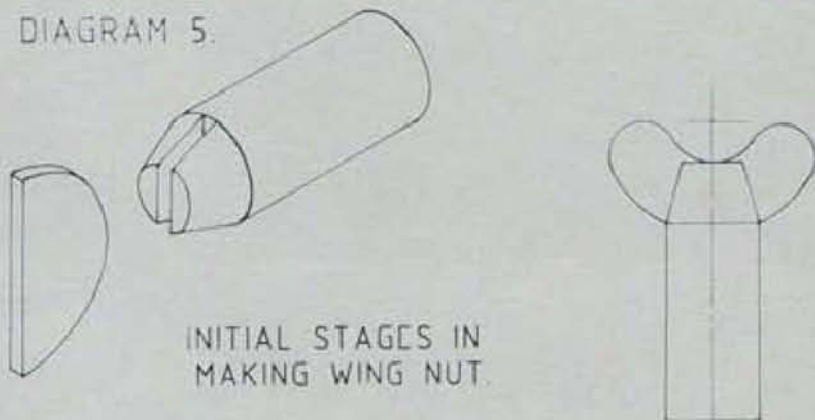
Lifting handle

I needed to provide a means of weighting the saw frame and decided that the weight-carrying rod could also serve as a convenient lifting handle. Accordingly, a pair of 3 in. pieces of $\frac{1}{2}$ in. square B.M.S. were prepared by drilling $\frac{1}{2}$ in. diameter holes through them at one end and slotting the other end to fit over the 'h' frame; these were then held in position by cheese headed screws. Initially I had planned for just one weight to be used but found that the saw cut rather slowly, so I added another weight of the same dimensions which improved matters considerably. A $\frac{1}{2}$ in. diameter plastic ball screwed to the end of the rod provided a comfortable handle.

Frame prop

One of the things which always irritated me when using a certain industrial hacksaw was the method by which the saw was supported before being released for the cut. This was by a huge ungainly prop which was controlled by a long rod and operated by the thumb. One had to take the not inconsiderable weight of the saw by the

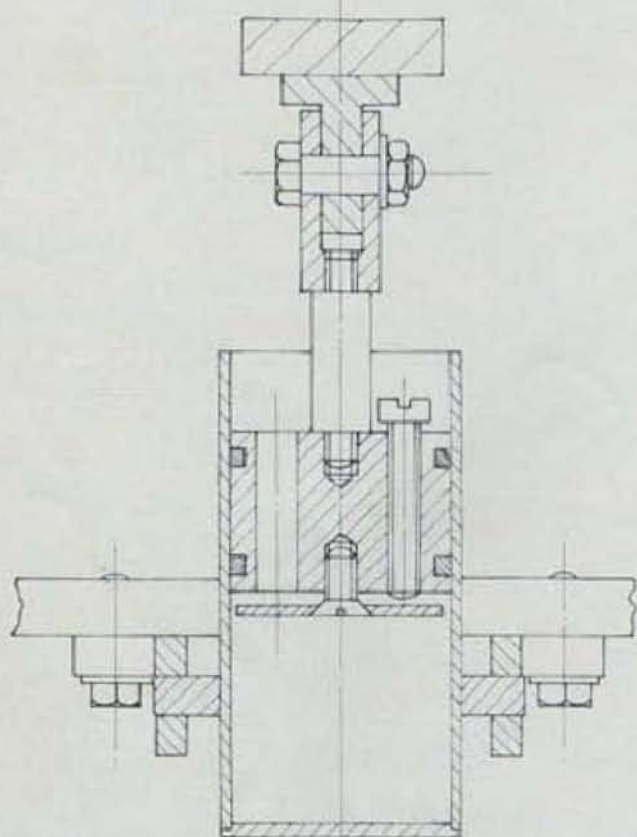
DIAGRAM 5.



INITIAL STAGES IN MAKING WING NUT.

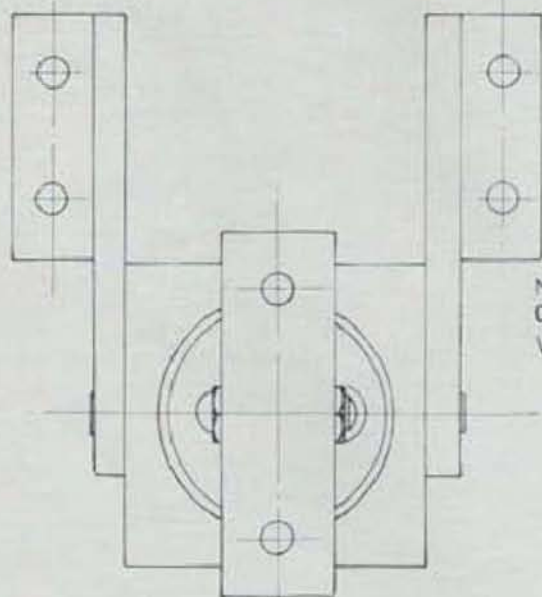
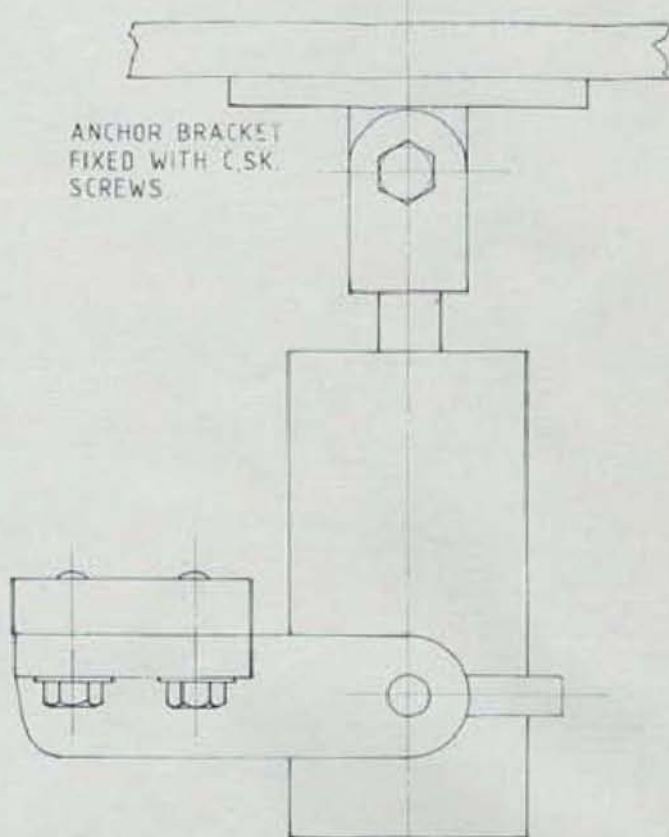
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DIAGRAM 6



SECTION THROUGH C.L.

ANCHOR BRACKET
FIXED WITH C.S.K.
SCREWS



MOTOR BRACKET
OMITTED IN THIS
VIEW

What makes John Brittain's clever power hacksaw design even more attractive and satisfying to use is the provision of a dashpot arrangement to provide back-stroke relief for the blade. Diagrams on this page describe it.

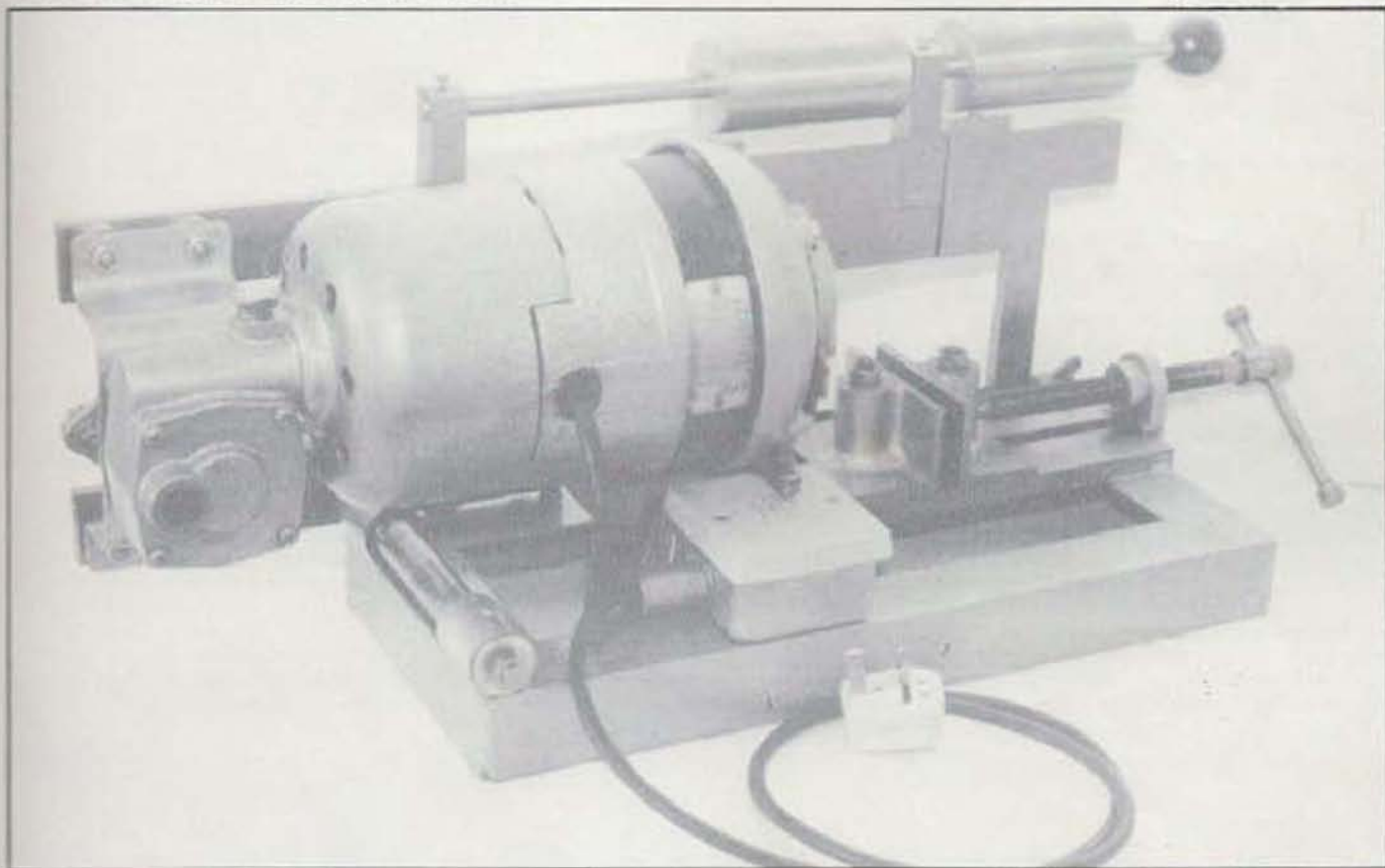
Parts of the dashpot – a vital piece of the design.



A POWER HACKSAW



Illustration above shows how the dashpot provides support to the saw on its return stroke. Below, a rear view of the completed saw.



lifting handle, press the knob at the end of the rod and, at the same time, attempt to reach down and switch on the machine – altogether a somewhat daunting feat. I determined that my saw should not be so awkward to use as this and accordingly devised a simple prop which is self-actuating when the saw is lifted.

The prop piece was made from a 2 in. length of $\frac{1}{2}$ in. $\times$ $\frac{3}{8}$ in. B.M.S. shaped in the form of a quadrant at one end and drilled at the other end with a $\frac{1}{2}$ in. diameter hole for a pivot pin. The pin was turned down from $\frac{1}{2}$ in. diameter B.M.S. to $\frac{1}{8}$ in. diameter and then reduced again to $\frac{1}{16}$ in. diameter and threaded $\frac{1}{4}$ in. B.S.F. the distance between the shoulders being a few thousandths of an inch greater than the thickness of the base side. The end of the pin was then cross-drilled for a tommy bar which was

made a press fit in the hole. These components were assembled with a nut and washer so that when the saw is in the raised position, its weight is taken on the point of the prop's quadrant shaped end. Immediately the frame is lifted, the weight of the tommy bar causes the prop to pivot off its point and allows the saw to descend. The quadrant shape ensures that no jamming occurs during the descent.

Dashpot (see Diagram 6)

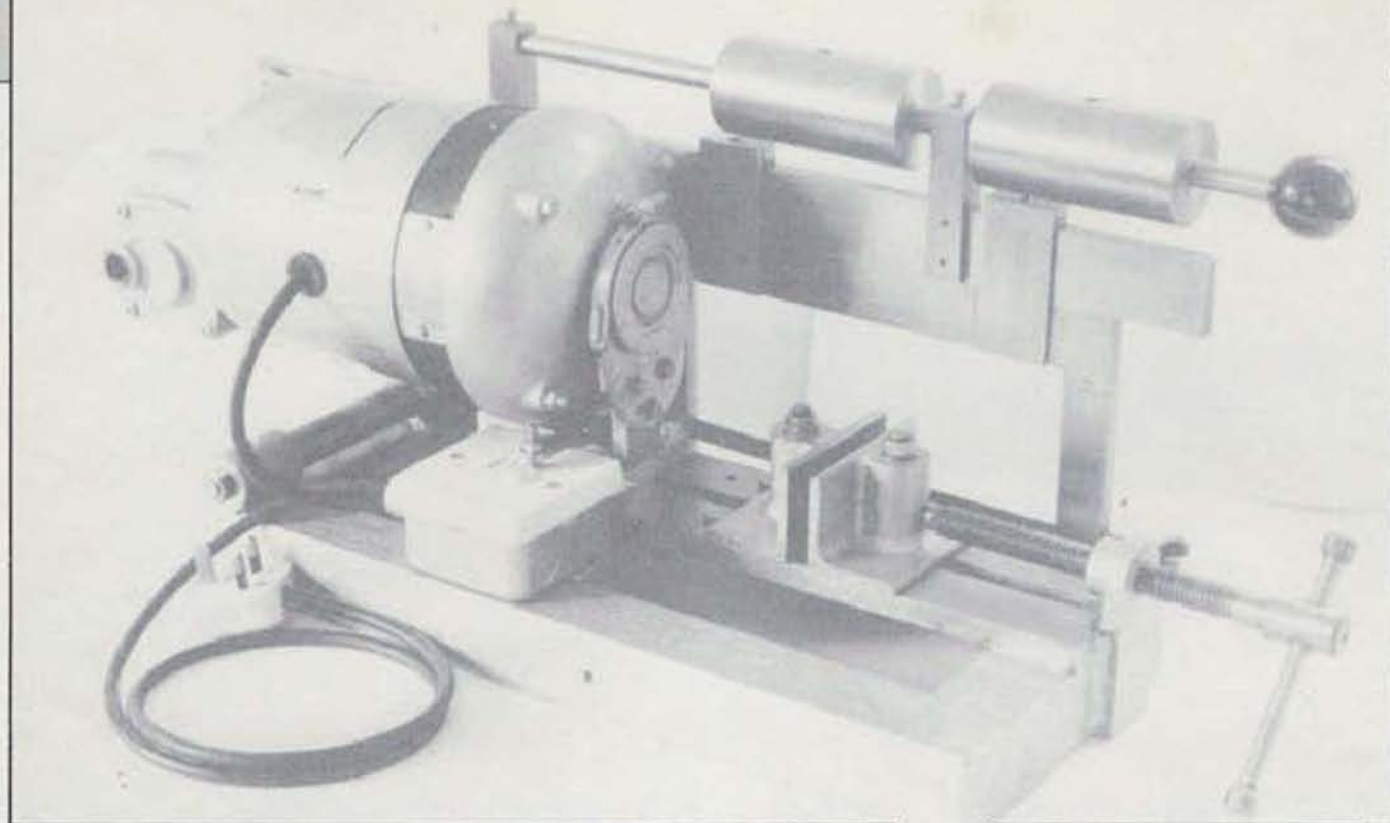
When first putting the saw to use, a rather undignified thump which accompanied the completion of each cut prompted me to look for some method of controlling the descent. A dashpot was the answer but where to hang it was the problem. A dashpot is a simple damper

consisting of an oil cup and piston. As mentioned earlier, at the time of making the motor support bracket, I entertained fanciful notions of using it some way to hold such a device but space was so restricted that I kept dismissing the idea. Finally, however, the accumulation of thumps crystallised my thoughts and I hit upon the idea of suspending the cylinder on trunnions in the space beneath the bracket.

Rummaging around amongst my scrap, I produced a piece of 1 in. diameter brass tube which had certainly seen better days but which I thought could be pressed into service. After removing several dents by careful planishing on a piece of round bar, I cut the tube to length and skimmed both ends in the lathe. A flanged base was turned and silver soldered into one end of it, after which I turned my attention to the trunnion plate. This I made from a 2 in. length of 2 in. $\times$ $\frac{1}{2}$ in. B.M.S., on each end of which I turned a $\frac{1}{2}$ in. long by $\frac{1}{2}$ in. diameter trunnion before boring its centre out for the

cylinder. The trunnion support brackets were fabricated from $\frac{1}{2}$ in. $\times$ $\frac{3}{8}$ in. and $\frac{1}{2}$ in. $\times$ $\frac{1}{4}$ in. B.M.S. pieces, silver soldered rather than welded together to ensure their squareness. These were then screwed to the underside of the base cross-member in a position where the cylinder would lie centrally beneath the motor bracket.

The cylinder was then slid down its trunnion plate so as to ascertain its optimum position, allowing for tilting, before being sweat soldered. The piston was turned an easy fit in the cylinder and grooved to receive two 'O' rings; five $\frac{1}{8}$ in. diameter oil holes were drilled through it and a sixth drilled and tapped 2 BA for the damping disc adjusting screw. The disc itself was parted off a little below $\frac{1}{8}$ in thick, drilled and countersunk for it to be held loosely in position by a 2 BA



A view of the machine showing the simple but highly effective switching arrangement which uses an ordinary rocker switch.

countersunk screw. The piston rod fork end was made from three pieces and silver soldered together; this was then joined to the piston by a $\frac{1}{8}$ in. diameter rod, shouldered and threaded at both ends, the distance between the shoulders being a mere $\frac{1}{8}$ in.

The fork end anchor bracket was another easy silver soldering job which, on completion, was duly bolted to the fork end with the piston in the cylinder in order for me to ascertain the best position for fixing to the underside of the motor bracket. Space was so limited that I did this fixing with countersunk rather than hex. headed screws since the anchor bracket came perilously close to the top of the cylinder.

NB: It should be pointed out to the less experienced that the main purpose of fitting a dashpot is to provide backstroke

relief for the blade. This was achieved more positively in my case by displacing the blade $\frac{1}{8}$ in. out of parallel with the saw frame.

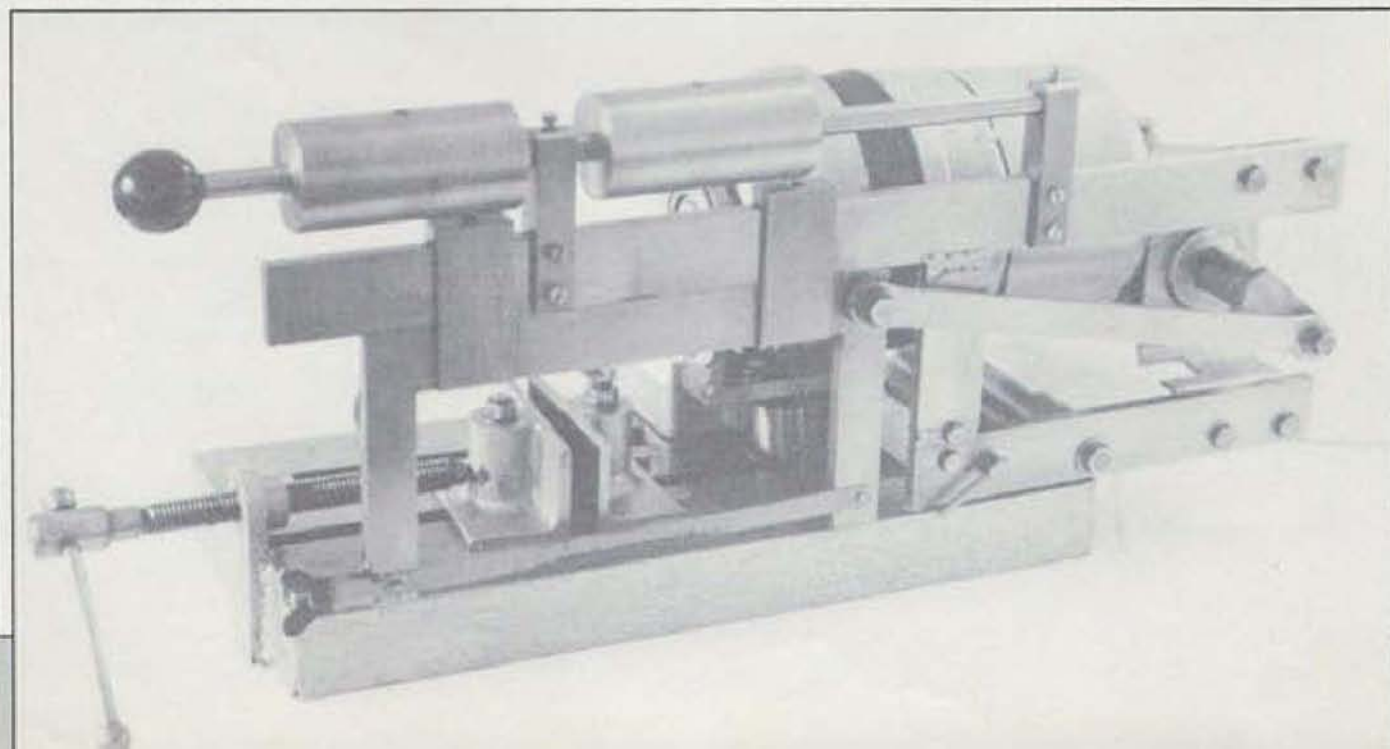
Stop switch

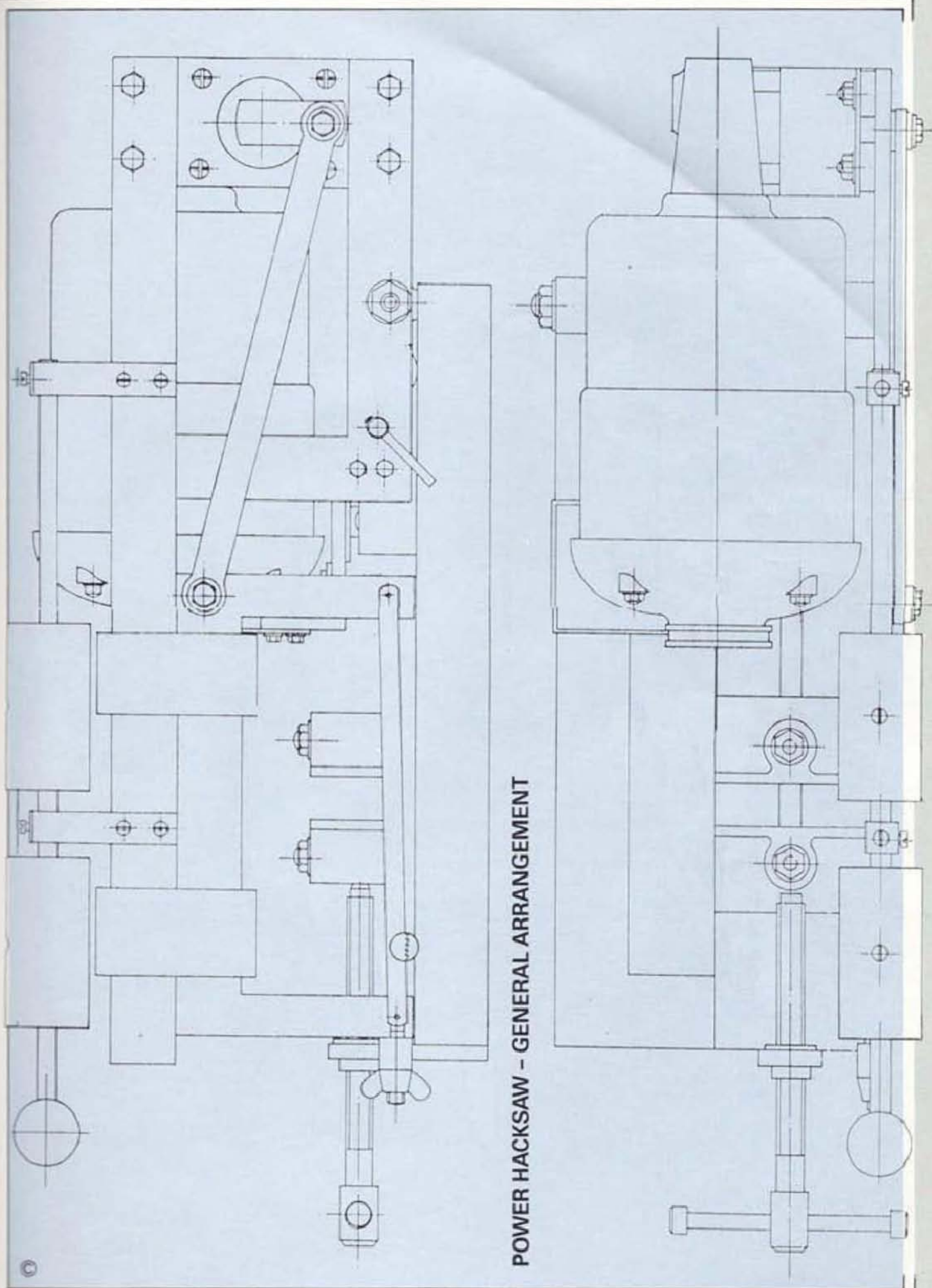
An automatic stop switch is, in my view, essential on a power hacksaw; so I purchased a standard 15 amp fused rocker switch and fixed it to the base on the opposite side from the 'H' frame. I was then able to screw a 'trigger' to the motor bracket which, when fitted with an adjusting screw and locknut, cut the motor at the appropriate moment.

As is obvious from the text, the whole project was executed on a 'play it by ear' basis, with no formal drawings made unless one counts the initial full size layout.

Since I regarded the job as largely experimental, I expected to redesign and remake quite a number of items and was therefore reluctant to spend time on drawing out individual components, preferring to rely on freehand sketches and measurements taken from the actual work as it progressed. In spite of this, very little has needed to be altered and, so far, the saw has functioned with every satisfaction. As mentioned earlier, I decided to add an extra weight in order to facilitate faster cutting; I have also provided stops for the rear vice jaw since it seems somewhat reluctant to 'stay put' even when tightened firmly.

The machine has been in use for a considerable time and has become a most useful addition to the workshop (to date, the largest job it has tackled is cutting a piece of 2 $\frac{1}{2}$ in. square steel) – and I find myself wondering, as I'm sure we all do when we have become used to yet another labour-saving device, 'how did I manage without it?' 





POWER HACKSAW - GENERAL ARRANGEMENT



The two completed devices; at left, the acoustic edge-finder/tester and meter at right. The probe is in the foreground.

saw or mark around the circumference of the circle. Drill a number of small holes within the circle diameter, almost touching each other, and then, using a knife edge, warding file or junior hacksaw blade, cut into each hole until the centre falls out. Finally, finish off by using a half round hand file to make the hole the correct diameter to allow the meter to drop in easily. However, if a rectangular meter is used as an option instead of the suggested round one, the same procedure can be followed, a rectangular hole being cut for that type of meter instead.

Stage 2

At the bottom of the plastic box opposite the meter, drill a $\frac{1}{2}$ in. diameter hole to accept a rubber grommet as in drawing one and three.

Stage 3

Measure and mark, then drill the two 2.5mm clearance holes for retaining the two brass contacts (or tin plate) strips in the plastic case. Countersink these on the outside to accept the countersunk headed 2.5mm screws, **drawing five**.

Stage 4

Drill 2.5mm clearance holes in the centre of both brass (tin plate) strips as in **drawing five**.

Stage 5

One of the brass (tin plate) strips will be required to have two extra 5mm clearance holes drilled in it to allow the continuity testing contacts to pass through from the outside of the plastic case without actually making contact; refer to **drawing five** for details. These two holes are drilled to match up with clearance holes which are drilled in the appropriate position in the plastic case. Refer to **drawing three** if in doubt.

Stage 6

The continuity contacts were actually two large brass drawing-pins which were pushed through the two holes already drilled in the case and fixed with epoxy adhesive. A piece of insulating sleeving is passed over the drawing-pin end which ensures that the pins are fully insulated from the brass (tin plate) strips. Solder a thin wire onto each pin ready for wiring up in the final process. Make the wire long enough so that it can be cut to the required length in the final wiring. The size of wire should be about 22 s.w.g. insulated.

Stage 7

File a small slot deep enough in the back (lid) of the box (case) to accept the flat hook for hanging the instrument whilst in use. The hook can be glued in place with epoxy adhesive.

ELECTRONIC SETTING UP DEVICE

Simple electronics are now a fact of life and with us, in some form or another, every day. This setting-up device and fuse tester described by Edgar Powell could be considered as an easy way to start getting to know a little about the subject, whilst finishing with a very useful piece of equipment. All the parts are easily obtainable from shops dealing with radio and electronic spares.

An electric setting-up device and fuse tester

Like many other engineers, modellers or professionals, who use a vertical milling machine, have at some time or other used the mechanical type of edge finder to get a reference edge of a workpiece which has been set up in the machine. Of course, it is possible to get a reference by using a piece of damp cigarette paper and gently offering the milling cutter up to it until the paper is peeled away — if you have a steady hand that is! In moving the milling table to just about remove the paper with the cutter, you can be within half a thousandth of an inch or so off the work edge, but of course, it is a fair bet that in the process you will cut through the paper and mark the edge of the workpiece. Not a very desirable state of affairs.

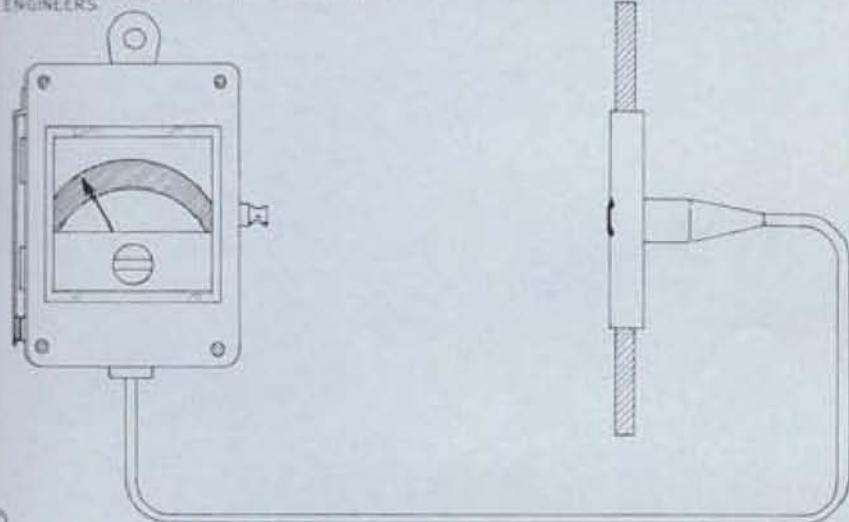
However, having used these two methods, I kept thinking there must be a more modern approach to this problem, so

I made this device which does not need to be revolved in the collet of the machine or take a lot of specialised tools and expense to make. Just a few electronic bits and pieces with small adaptations and it makes a versatile instrument. This is how I made a start, and I have broken the instrument down into paragraphic stages to make it easier.

Construction of the meter type device (Stage one).

Obtain the appropriate plastic box and begin to work on it by firstly referring to the required drawing which in this instance is **drawing three**. Mark off the final position of the meter on the front of the plastic box (i.e. the back (lid) of the box has appropriately four self-tapping screws to hold the lid on, which can be used as datums). From the centre, with a compass, make a circle in the middle of the box, the diameter being that of the meter movement. Cut the hole by using a hole

①
"PICTORIAL FRONT VIEW OF
ELECTRONIC SETTING-UP DEVICE
& FUSE TESTER FOR MODEL & INDUSTRIAL
ENGINEERS



Stage 8

You should now have reached the stage of being able to assemble all the bits and pieces referring to **drawing three** as guidance, taking some minor precautionary measures particularly with the continuity contacts ensuring that the pins and wires are insulated from the springy brass strips and are only connected to the appropriate part of the circuit required. Refer to **drawing seven**.

Stage 9. Manufacture of the probe

Use a piece of round solid insulation material such as good quality Tufnol or any insulating material which resists warping as shown in **drawing five**. Drill and ream a hole to make a sliding fit for a 6mm diameter stainless or silver steel rod, cut off two lengths longer than required and face

the ends true in a lathe until the required length of each has been achieved and any sharp edges removed. The next move is to smear a small amount of epoxy adhesive about a third of the way along each spindle and all the way round and slide them gently into the reamed hole until equal lengths of rod are protruding from the insulated piece. Keep in mind that a gap about 1mm to 2mm must be left between the two spindles in the centre. The method I used was to push the spindles together until they touched, then withdrew each one about 0.5mm. This leaves the necessary insulated gap. After leaving the glue to harden off for 24 hours, take the now almost complete probe and drill two 1mm holes as shown in **drawing five**, remembering to countersink one side of the holes after drilling them. Now put one of the spindles of the probe in a collet or chuck on the lathe and true up the other



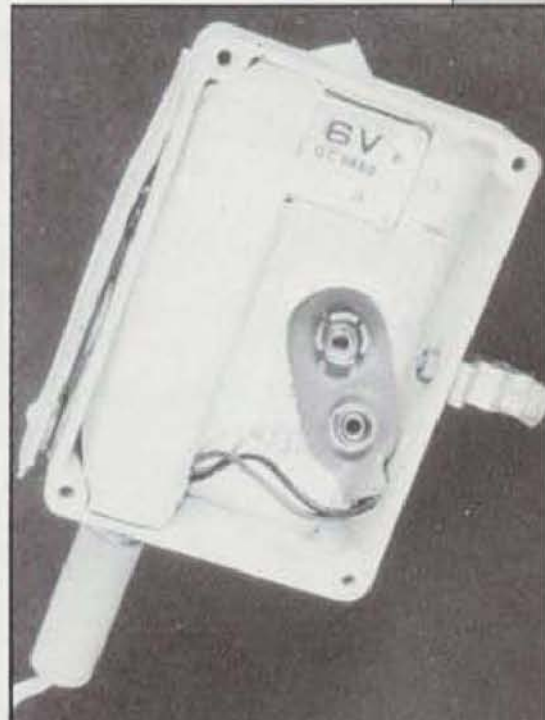
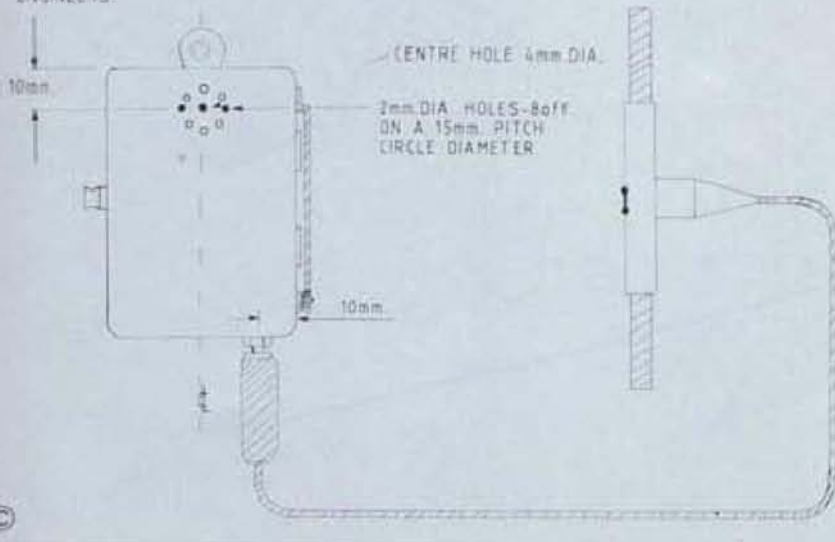
Interior of the device with meter.

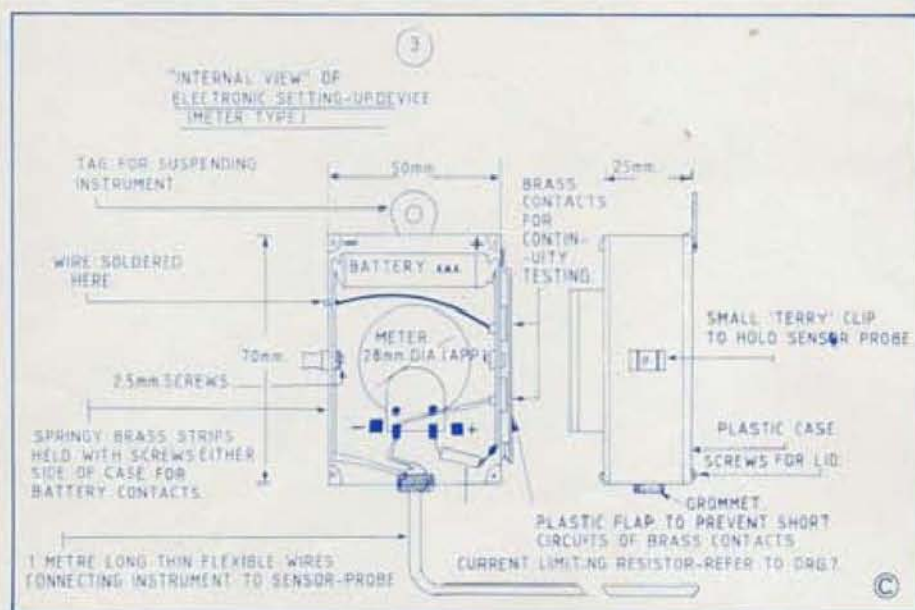
spindle taking off just enough material to bring it down to an even figure in metric or Imperial measurements (I made it 5mm) for ease of working with the probe.

Having done this, reverse the probe and repeat the operation on the other spindle, bringing that down to the same diameter as the first. All that remains is to press the small 1mm pins into the pre-drilled holes provided into the spindles and connect the required length of wire by soft soldering to the pins, remembering to slide a plastic gaiter over the wire and over the pins before continuing to wire up the other end

Inside the acoustic device, battery removed. Simplicity is self-evident.

②
"PICTORIAL FRONT VIEW OF
ELECTRONIC SETTING-UP DEVICE (ACOUSTIC TYPE)
& FUSE TESTER FOR MODEL & INDUSTRIAL
ENGINEERS





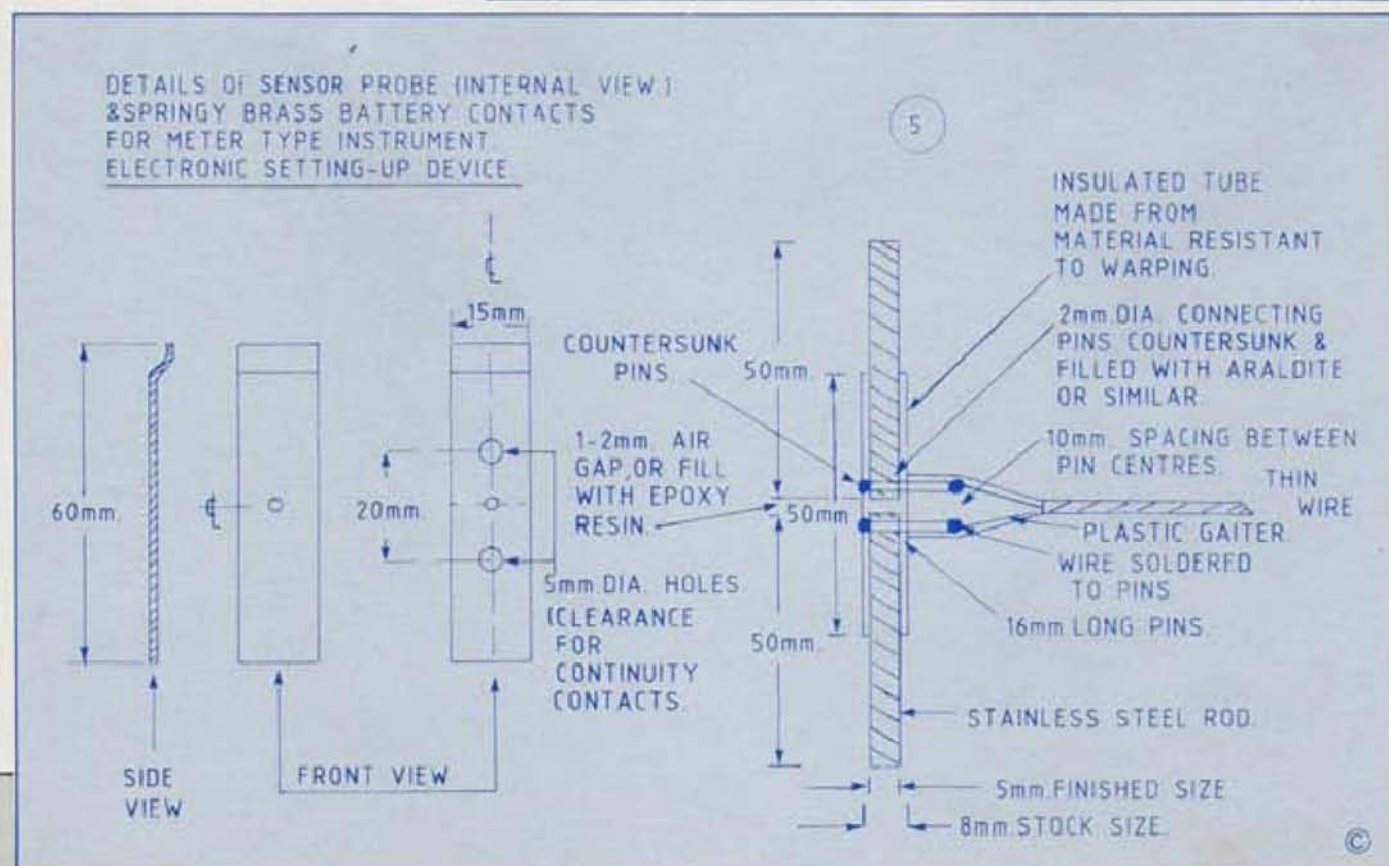
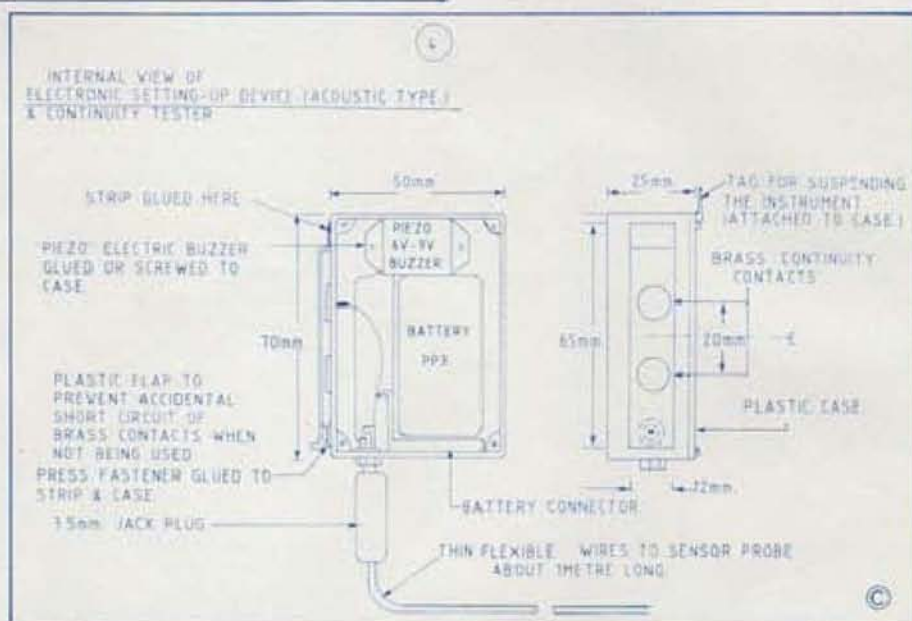
acoustic buzzer as in **drawing two and four**. Scribe a circle on the front of the box as in the drawing and proceed to drill 2mm holes around its circumference as shown. Now proceed with the construction as mentioned for the meter instrument, with just one exception. At the bottom of the box opposite the acoustic buzzer in the centre, drill the appropriate hole to accept the 3.5mm jack socket but ignore the instructions relating to the brass strips. Construction of the probe remains the same, or if you wish to make a simpler probe, but sacrificing some accuracy, take a piece of thick walled tube of good quality insulating material which will accept $\frac{1}{8}$ in. or 5mm diameter stainless steel, ground steel or silver steel rod and proceed as before, but without the trouble of turning the spindles.

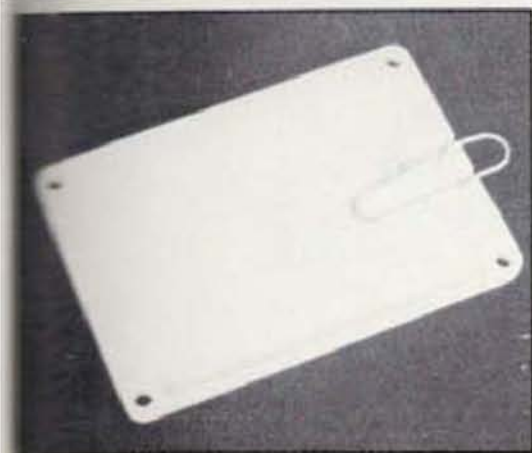
The plastic protection flap for covering the continuity contacts measuring about 1 in. wide and about 2 in. long was made

of the cable as in **drawing five**. Now carry on wiring up the circuit and, when finished, insert the recommended battery taking note of the correct polarity. Short circuit the probe spindles together using a short length of bare wire; if all is correct, the meter will read in the right direction. If not, reverse the meter connections. If you are using a small potentiometer as a limiting resistor for the meter as in **drawings three and seven**, adjust this until the meter reads full scale. If you wish to test the continuity contacts, the same procedure can be used.

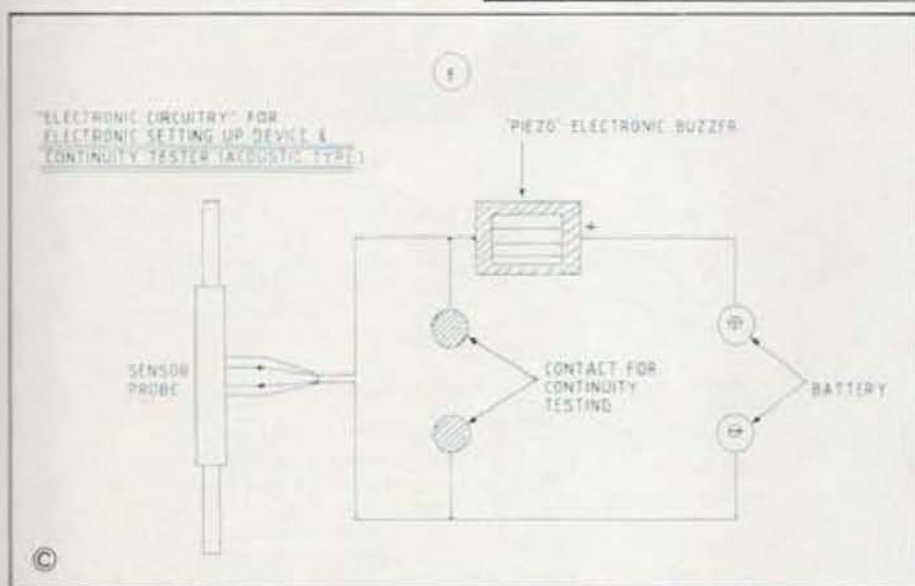
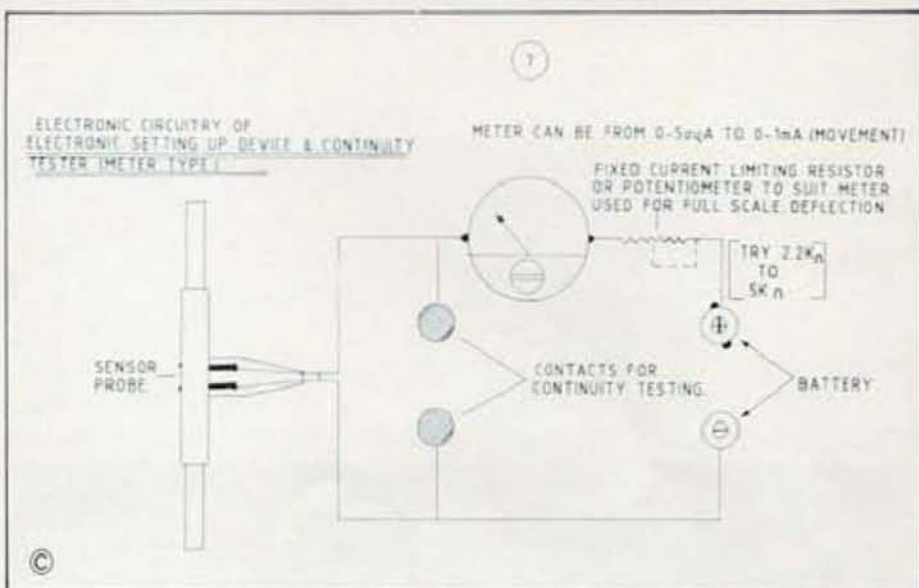
The acoustic edge finder/tester

This was made as an option to the meter instrument. I had in mind a simpler device (which would probably cost less as well), although it is perhaps a little less sensitive in use. Nevertheless, it's a useful instrument to make. Obtain a plastic box as before and mark the position of the piezo





Nothing more sophisticated than a humble paper clip fits into slots in the lid and acts as hanging loop.

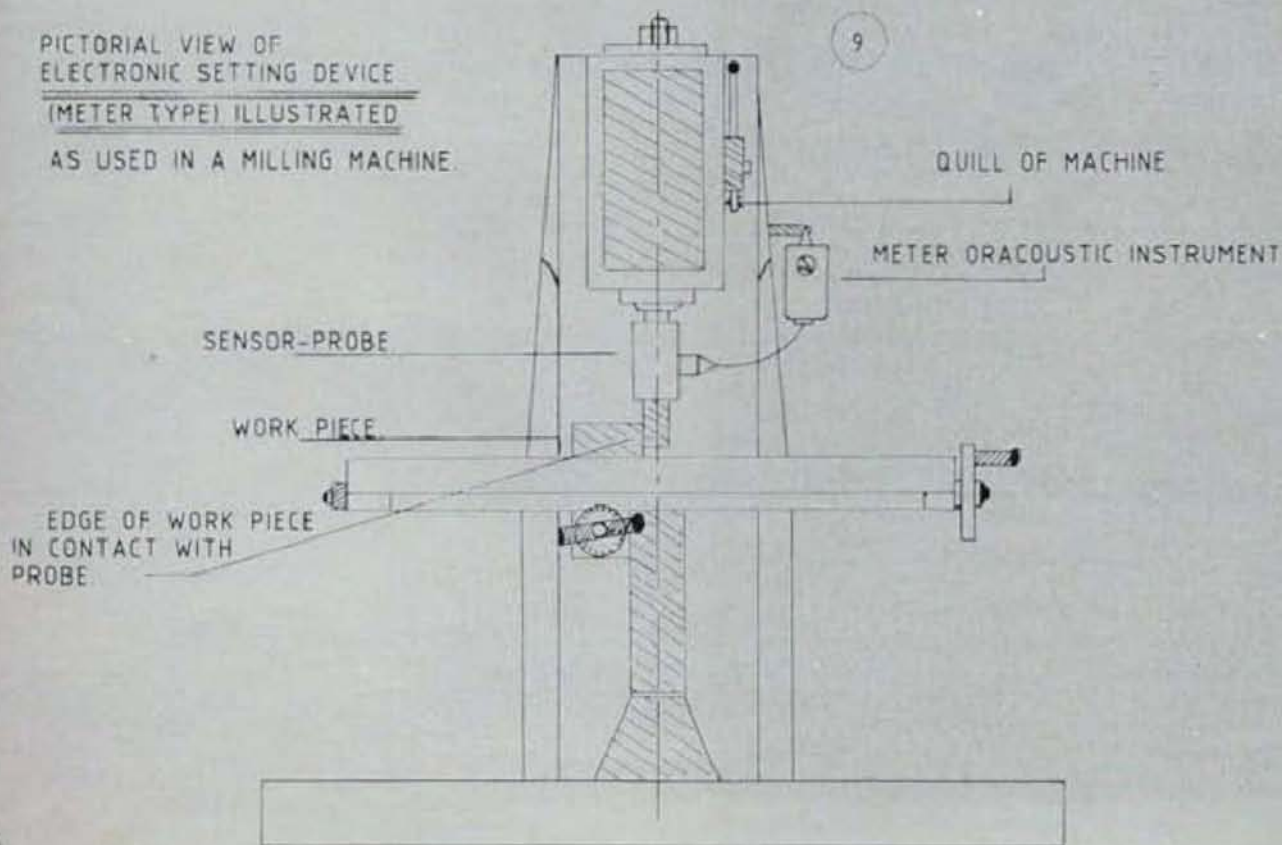


from an old washing-up liquid bottle with a press-stud, one half glued to the bottle and the other half to the box. (Talk to the wife nicely to get one of these from her sewing box!)

Extension piece for the probe

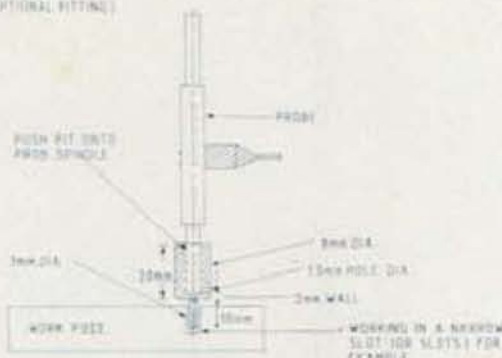
Drawing ten shows an attachment which enables the probe to be used in such situations as narrow slots, etc. This was made from steel but could be brass if so desired. Here again it would be advisable to make the turned-down end of the attachment a specific diameter (I made it 3mm) A hole is drilled and reamed into the attachment to give a gentle push fit into the probe spindle to make it easily removable as can be seen by drawing ten.

PICTORIAL VIEW OF ELECTRONIC SETTING DEVICE (METER TYPE) ILLUSTRATED AS USED IN A MILLING MACHINE.

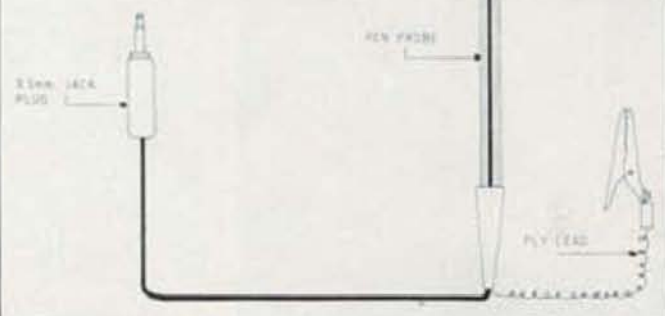


EXTENSION PEEK FOR PROBE
(ELECTRONIC SETTING UP DEVICE)
& CONTINUITY TESTER

MATERIAL: STAINLESS STEEL
(THESE ARE AS AN OPTIONAL FITTING)



PEN PROBE ATTACHMENT
FOR ACOUSTIC SETTING UP DEVICE



Parts list (Fig. 6) for electronic setting devices (meter and acoustic)

Quantity		Purchased from	Approx cost
2	Plastic boxes 70mm×50mm×25mm	Radio and electronics retailer	80p to £1
1	Meter (small size)	Radio and electronics retailer	£2.50
2	Small Terry clips	Hardware or car component shop	5p each
1	Small rubber grommet	Radio and electronics shop	2p each
1	$\frac{1}{2}$ to 1 watt resistor (2.2k Ω) (or variable potentiometer) (5k Ω)	Radio and electronics shop	5p for res. 25p for pot
2	1 meter length of flexible twin wire	Radio and electronics shop	15p a metre
4	Lengths of 50mm×6mm stainless steel rod or silver steel or 5mm dia	Model engineering shop	50p a ft length
2	Tufnol or insulated rods (solid)	Model engineering shop	50p a length
2	Thick wall Tufnol tubes (internal dia. to fit 5mm stainless or silver steel rod) if required	Model engineering shop	50p a length
4	1mm diameter pins (round brass nails - with heads)	Model Engineering shop or hardware/DIY	30p a packet
4	Large-headed brass drawing pins (office type)	Stationers newspaper shop etc	20p a packet
2	2.5mm screws and nuts	Model engineering shop	30p a packet
2	Plastic gaiters	Car component shop	2p each
2	Pieces of brass shim (or use a piece of tinplate)	Model engineering shop	40p a sheet
2	Lengths of (about 1 metre) connecting-up wire insulated about 22 swg	Radio and electronic shop	10p
2	Metal tabs (for hanging instrument) (spade terminal)	Radio and electronic or car component shop	3p each
1	Battery type AAA	Radio and electronic etc shop	25p
1	Battery type PP3 and battery connector	Radio and electronic etc shop	Both £1
1	Piezo-electric buzzer 6v to 9v working	Radio and electronic shop	75p to £1
2	3.5mm jack plugs	Radio and electronic shop	35p
1	3.5mm jack sockets	Radio and electronic shop	25p
1	1 metre length of twin flexible wire (for pen probe)	Radio and electronic shop	15p a metre
1	Crocodile clip	Radio and electronic shop	30p a packet
1	1 metre length of single flexible wire for pen probe fly lead	Radio and electronic shop	15p a metre
1	Short length of 1mm internal dia. insulated sleeving	Radio and electronic shop	10p
1	2mm dia. brass rod or stiff copper wire (6") (for pen probe)	Model engineering shop	20p

APPROXIMATE COST OF BOTH INSTRUMENTS

£10.00

The pen probe attachment for the acoustic device

This attachment can be made if you wish to extend this type of device even further, especially when used by electronic buffs for tracing wiring circuits. Simply obtain a used ballpen, remove the ink insert and replace with a stiff brass or copper wire which is a push fit into the plastic tube and glued. Make one end into a semi-sharp point.

A pair of flexible wires are used for this fitment as in **drawing eleven**. One wire is soldered to the pen probe, the other used as a fly lead. A 3.5mm plug is fitted on the other end and can be plugged into the socket of the acoustic device instead of the main probe. Both are fully removable when not in use and portable, of course, but do not allow it to corrode or it will eat away all your circuitry!

Method of use

Place the sensor-probe in the appropriate collet in the quill of the milling machine, hang the instrument (meter or acoustic) in a convenient position so that the meter can be viewed, offer the edge of the sensor-probe up to the edge of the workpiece until the meter registers or the acoustic buzzer sounds, then raise the quill until the probe clears the workpiece. Move the worktable forward or backward as appropriate until it has moved half the diameter of the probe. Having done this, the centre of the quill is now centralized with the edge of the workpiece. You now have a reference point to work from. During this operation, the quill section remains stationary.

This illustration shows how part of a plastic bottle, stuck down and held with a press-stud, acts as an insulator.



Model Engineers' Workshop

MODEL ENGINEERS' WORKSHOP

IN OUR NEXT ISSUE!

Our packed Autumn issue offers many more invaluable projects to construct, and sound practical advice on the techniques required to make them. Among the line-up is this super low cost, high quality and exceptionally rigid bandsaw which can be made on an average 3 in. lathe and requires stock materials in its construction. You'll find it an indispensable addition to your machinery collection!

Next comes an easily built wood-turning lathe of medium capacity which is capable of dealing with most work required by the home machinist, plus details, drawings and photographs on the construction of a small milling device for milling very tiny components which cannot be dealt with on a vertical slide or normal type of milling machine or attachment.

We'll also be describing a useful indexing attachment which can be made cheaply and easily and represents an inexpensive answer to this highly important aspect of model engineering. Using change wheels but of unusual construction, it is just one of many ways of dividing and indexing which will be described over the next few issues.

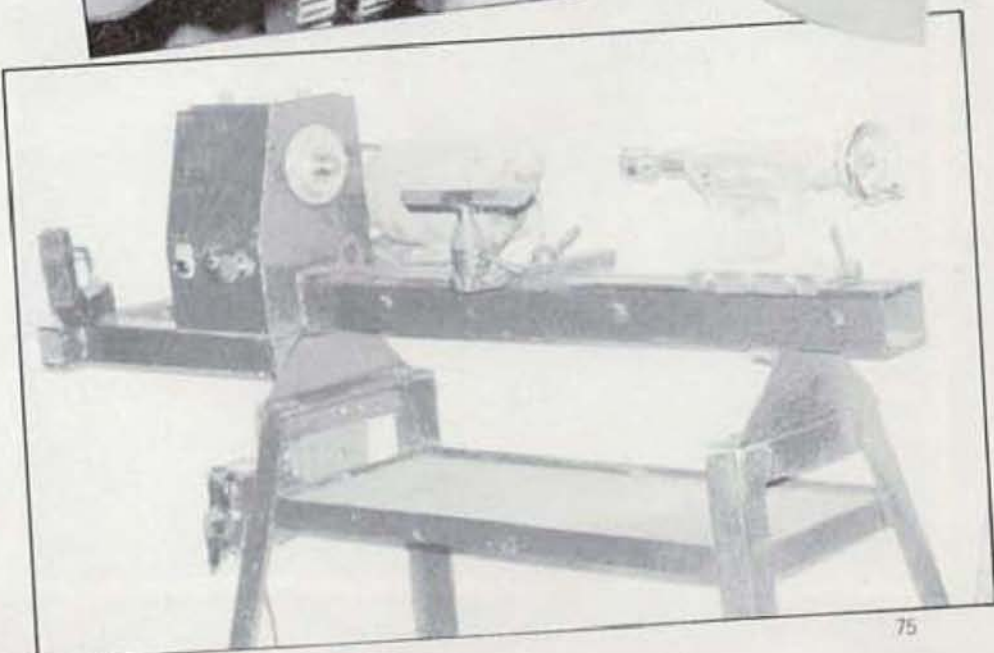
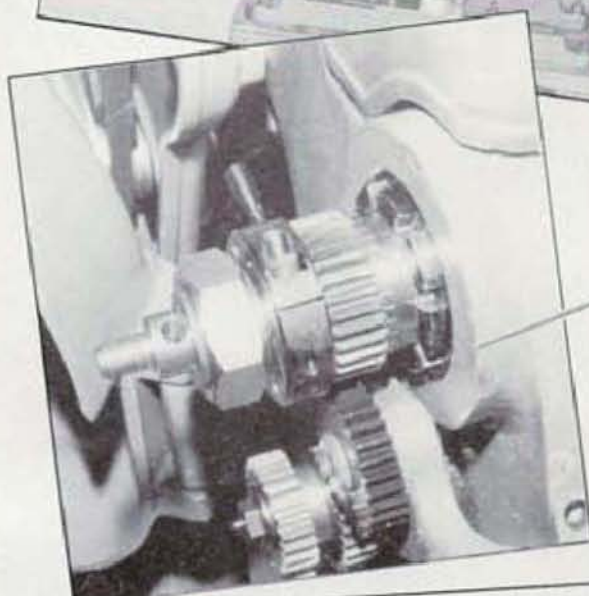
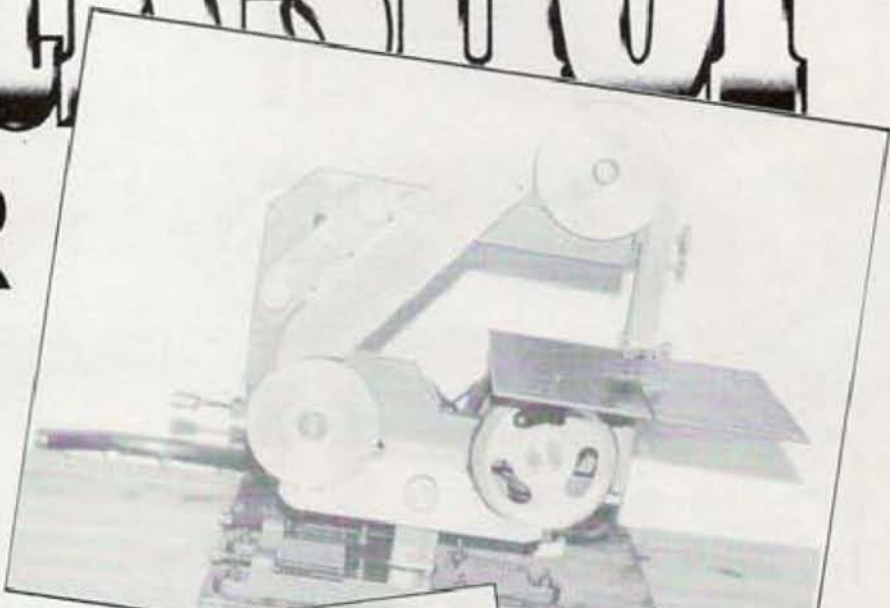
Next comes a high quality knurling tool which should help you to overcome the difficulties often encountered in this common operation; it will transform indifferent results into work you'll be proud of! We take a look at high temperature soldering in the Autumn issue, too, with a review of the tools, materials and techniques involved ranging from operations involving the simple propane torch to more complicated methods.

We also offer an accurate device for positioning of cross-slide and saddle on the lathe which can be adapted for use on the milling machine as well, and discuss low voltage lighting for the workshop showing simply how to make safe, low power lamps to illuminate machines and benches. There's more, too, about electronics in the home workshop and, with the assistance of the manufacturers, a review of tungsten carbide tooling suitable for use by the model engineer. We'll describe the best way to obtain such equipment at the best possible prices and tell you how to get the best from it.

More tips, a visit to a workshop, a superb FREE pull-out set of working drawings and more small tools which are quick and easy to make, plus your letters and enquiries (if you write to us!) go to round off a mouthwatering line-up.

PUBLISHED ON SEPT. 14th. DON'T MISS IT!

Contents may be changed.



SCRIBE A

L I N E

One day, with your help, this will be the regular spot in our new mag for your letters! Seriously, since this is our first ever number, we have yet to receive your comments, enquiries and complaints. We hope you'll use this corner of MEW as a forum for the exchange of ideas and, if your letter takes the form of a technical question or plea for advice on working technique, so much the better. In future issues we hope to open a 'question and answer' service so feel free to drop us a line. We look forward to hearing from you!

This being the first issue of *Model Engineers' Workshop*, the only letters we have so far received have been from our contributors. We do intend, however, to publish any letters by readers that it is thought could be of interest to others. These will include queries and answers thereto. As we are not in a position to start at once in the way we hope to continue, it was thought to be a good idea if a résumé of recent queries received by the editor in another capacity and his answers supplied were to be included here in an abridged form.

Metric threads

The first enquiry dealt with, concerned someone who was rather puzzled over the metric system of threads. He had found details of the sizes available but was puzzled as they were called 'metric coarse' and he wished to know if there was a system of fine threads as well.

There are two series of threads, the coarse and the fine. If we go along to our

local hardware shop and ask for six or eight millimetre bolts then we will be given metric coarse series, this being the standard range and usually just called 'metric threads'.

Included in the coarse series we will find however that at times there are differing pitches for the same diameter. The increases in diameter are not consistent but are reasonably logical as the differences are larger as the diameters increase.

The fine series, too, has instances of diameters with a variety of pitches although generally these fall into the 'preferred', 'conduit' or 'spark plug' series. Again, diameters increase by greater amounts as they get larger.

It is as well to study the thread range and to decide which thread is most suitable for the purpose. Remember that if a thread is just described by a number then the coarse series will be used.

The system is, however, remarkably simple in one way. No chart of tapping sizes is needed at any time. Simply take the

pitch from the outside diameter and, hey presto! there is your tapping sized drill. For example, if we have an 8 x 1mm thread then a 7mm drill will do as tapping size. This is a fine series thread and it is also the one in the preferred series. If we take the standard or coarse thread then the pitch is 1.25mm and we will need a 6.75mm drill. 6.75 is not a standard size so we must go to 6.8mm which is!

For anyone who does not know the meaning of the term 'pitch' in relation to a thread, it is the distance between two peaks along the thread. In Imperial measurements we use the term 'threads per inch' but this is not practical in the case of metric threads, of course.

For the benefit of readers who have no knowledge of the system, a brief table is included below which should give a better understanding of the threads.

Quenching Oils

Another reader was interested in the type of oil used when quenching steel that has been hardened and tempered.

Traditionally, whale oil has been used but whether or not this is still available in these days of conservation is doubtful. Any good tool supplier can, however, supply quenching oil from one or more of a number of proprietary brands.

The Pittsburgh Lock

A somewhat different enquiry involved a Pittsburgh Lock, which a reader had heard of but had not been able to discover what the term meant.

It is a means of joining sheet metal work with a form of double fold. It was at one time used extensively but it is doubtful if it is often used these days as other methods of joining metal are now more common.

Blow Holes in Castings

Another reader was concerned with blow holes in an iron casting. The supplier would willingly change the casting for him but most of the machining had already been done and he wanted to know what could be done about it.

It has long been the practice in industry to fill faulty castings and the practice continues today. At one time, a common cement for cast iron was equal parts of sulphur and white lead, with a sixth part of borax. The fractured iron was left for about five days when all trace of the cement vanished and it was difficult to see that there had been a repair. Various mixtures were used for filling.

The editor once witnessed a massive cast iron casing over forty feet long and two inches thick which had fractured. It had been stitched together with steel staples and the gaps filled with epoxy adhesive. The casting was still in service years later. For hole filling these days an epoxy resin such as Araldite, mixed with a good quantity of cast iron dust, will make a very strong filler capable of accepting a lot of wear. Alternatively, Devcon and similar proprietary branded fillers are available. These are in common use in industry where the cost and inconvenience of replacing castings makes filling a more practical proposition. These fillers can be used to build up missing parts and are completely machinable when thoroughly set. They can also be used for making simple home castings.

COARSE SERIES		FINE SERIES		5.50	0.90	14.00	1.25 *
Diameter	Pitch	Diameter	Pitch	6.00	1.00	14.00	1.50 x
1.00	0.25	3.00	0.35 x	7.00	1.00	16.00	1.00
1.20	0.25	4.00	0.50 x	8.00	1.25	16.00	1.50 x+
1.40	0.30	5.00	0.75 x	9.00	1.25	18.00	1.00
1.60	0.35	6.00	0.50	10.00	1.50	18.00	1.50 x*
1.70	0.35	6.00	0.75 x	11.00	1.50	18.00	2.00
2.00	0.45	8.00	0.50	12.00	1.75	20.00	1.00
2.20	0.45	8.00	0.75	14.00	2.00	20.00	1.50 x+
2.30	0.45	8.00	1.00 x	16.00	2.00	20.00	2.00
2.50	0.45	9.00	1.00	18.00	2.00	22.00	1.50
2.60	0.45	10.00	0.75	20.00	2.50	22.00	2.00
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MODEL ENGINEERS' WORKSHOP

Please help us to help you by completing and returning this questionnaire. Your replies will tell us more about you, our readers, and will enable us to make *Model Engineers' Workshop* exactly the sort of magazine you want. What's more, it will cost you nothing (except, perhaps, five minutes of workshop time) because we'll pay the postage!

1) In regard to workshop usage, what is your favourite type of article?

- Techniques? ☐
 Construction details for machine tool aids and accessories? ☐
 Making new machinery or tooling? ☐
 Theory behind various workshop processes? ☐
 Other? (please state preference) ☐

2) What is the floor area of your workshop?

- Less than 50 sq.ft? ☐
 50 - 150 sq.ft? ☐
 150 - 300 sq.ft? ☐
 Larger? ☐

3) Is your workshop area

- Indoors (own room)? ☐
 Converted garden shed? ☐
 Outbuilding? ☐
 Garage, or part thereof? ☐
 Other? (please state) ☐

4) Workshop Equipment. Do you own:-

- A lathe? Yes ☐ No ☐
 If yes please tick centre height
 1-3 in. ☐ 3-4 in. ☐ 4-6 in. ☐
 Larger ☐
 Shaper? ☐
 Vertical milling machine? ☐
 Horizontal Milling Machine? ☐
 Offhand grinder? ☐
 Tool and Cutter Grinder? ☐
 Surface plate? ☐
 Drilling machine? ☐
 Soft soldering, brazing or silver soldering apparatus ☐
 Arc welding equipment? ☐
 MIG or TIG welding facilities? ☐
 Oxy-Acetylene? ☐
 Oxy-Propane? ☐

5) Do you also build:-

- Locomotives? ☐
 Traction Engines? ☐
 Internal combustion engines? ☐
 Hot air engines? ☐
 Model boats? ☐
 Model aircraft? ☐
 Model cars? ☐
 Clocks? ☐
 Other models? (please specify) ☐

6) Please indicate which of the following you own and use:-

- Micrometer? ☐
 Vernier Caliper? ☐
 Scribing block? ☐
 Height gauge? ☐
 Wobbler? ☐
 Depth gauge? ☐

7) Is your workshop:-

- Insulated? ☐
 Heated? ☐
 Free from condensation? ☐

8) Do you prefer to make or purchase ready-made the following items:-

- Lathe tools? Make ☐ Purchase ☐
 Form tools i.e. gear tooth cutters? Make ☐ Purchase ☐
 Machine tool accessories, e.g. Steadies, rotary tables, stops, etc? Make ☐ Purchase ☐

9) Would you be interested in features on any of the following?

- Other model engineers' workshops? ☐
 Visits to industrial premises, with the accent on production techniques? ☐
 Interviews with well known hobbyists, with a bias towards their workshop methods? ☐
 Occasional repeats of previously published projects, updated as appropriate? ☐
 Articles on workshop related matters, such as; repair and overhaul of electric motors, renovation work on older machine tools, adapting used industrial machinery to the needs of the model engineer, potential, but unlikely sources of materials, guidance on where to obtain unusual materials, etc? ☐

10) Looking at the style of drawings used in the model engineering press have you a preference for any of the following:

- First angle projection? ☐
 Third angle projection? ☐
 Dimensioned work sketches? ☐
 Orthographic projections? ☐
 Drawings supplemented by photos showing difficult or unusual operations in progress? ☐

11) Do you attend any evening class, or other outside organised workshop?

Yes ☐ No ☐

12) Are you a member of a model engineering club or society?

Yes ☐ No ☐

13) Do you prefer to work in:-

- Metric units? ☐
 Imperial Units? ☐
 A mixture of the two? ☐

14) Approximately how much do you spend per year on workshop equipment and materials?

- Up to £100 ☐
 £101 - £250 ☐
 £251 - £500 ☐
 More than £500? ☐

15) Do you work with wood as well as with metal?

Yes ☐ No ☐

16) Are there any particular workshop related products or services that you have difficulty in obtaining or sourcing?

Please state

17) Do you understand electronics as applied to the workshop?

- Fully ☐
 A little ☐
 Not at all ☐

18) Are you a regular reader of any of the following modelling magazines?

	Regular	Occasional
Model Engineer	☐	☐
Engineering in Miniature	☐	☐
Locomotives Large and Small	☐	☐
Workshop Masters	☐	☐
Other? (please state)		

19) What is the largest influence on your purchasing decisions?

Published reviews of the product? ☐
Magazine product advertising? ☐
Personal recommendation or choice? ☐

20) If *Model Engineers' Workshop* were to be published more frequently, would you prefer that frequency to be:-

Alternate monthly? ☐
Monthly? ☐
Satisfied with current quarterly frequency? ☐

21) Based on your opinion of this first issue of *Model Engineers' Workshop*, do you intend to buy future issues?

Yes ☐ No ☐

22) Do you intend to take out a subscription to *Model Engineers' Workshop*?

Yes ☐ No ☐

23) Would you like to receive, through the post, information about special offers on model engineering items?

Yes ☐ No ☐

24) Which one of the following age categories do you fall into?

Under 30 yrs? ☐
30 - 39 yrs? ☐
40 - 49 yrs? ☐
50 - 59 yrs? ☐
60 - 69 yrs? ☐
70 yrs and over? ☐

25) May we have your name and address?

Name

Address and Postcode

26) Finally, is there any single topic or workshop aspect which you would like to see covered in future issues of *Model Engineers' Workshop*?

Thanks for your help.

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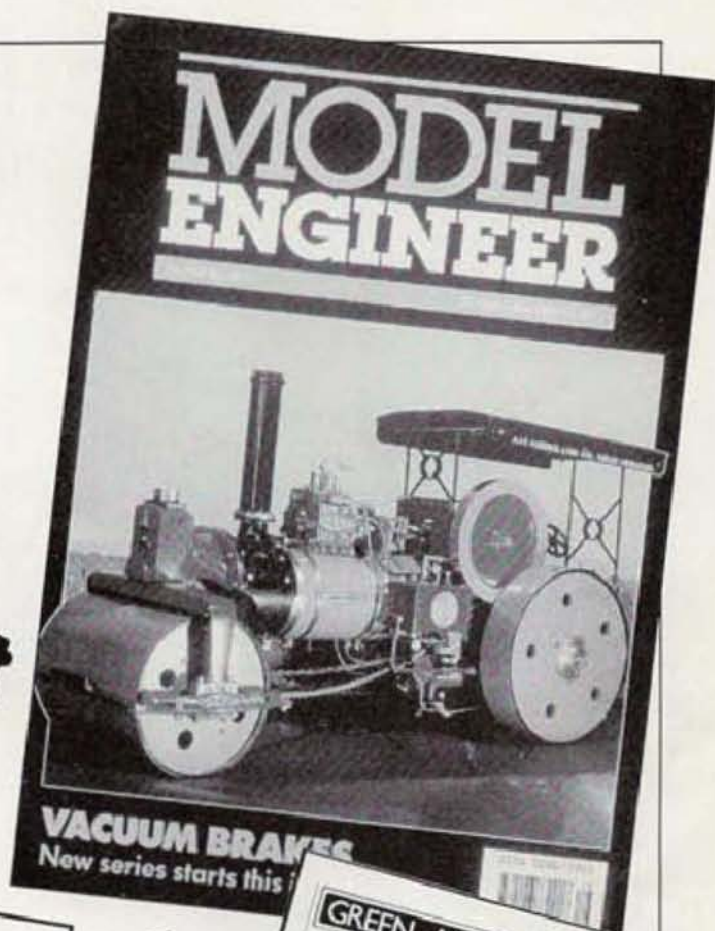
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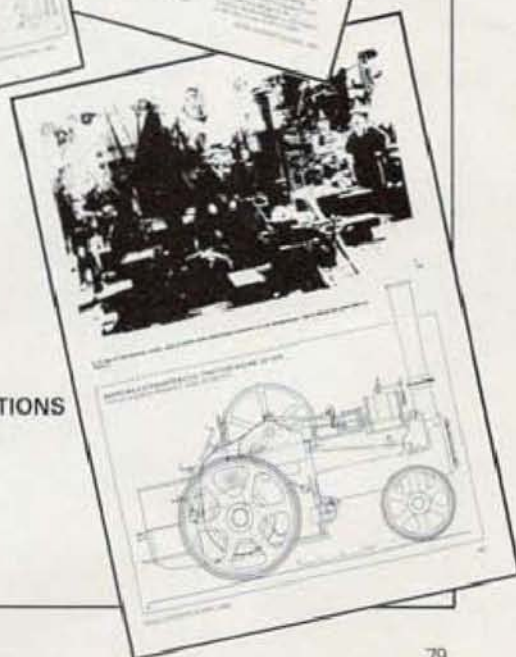
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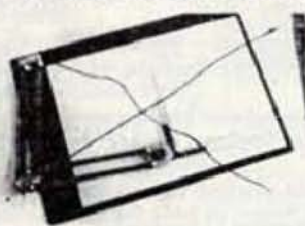
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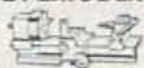
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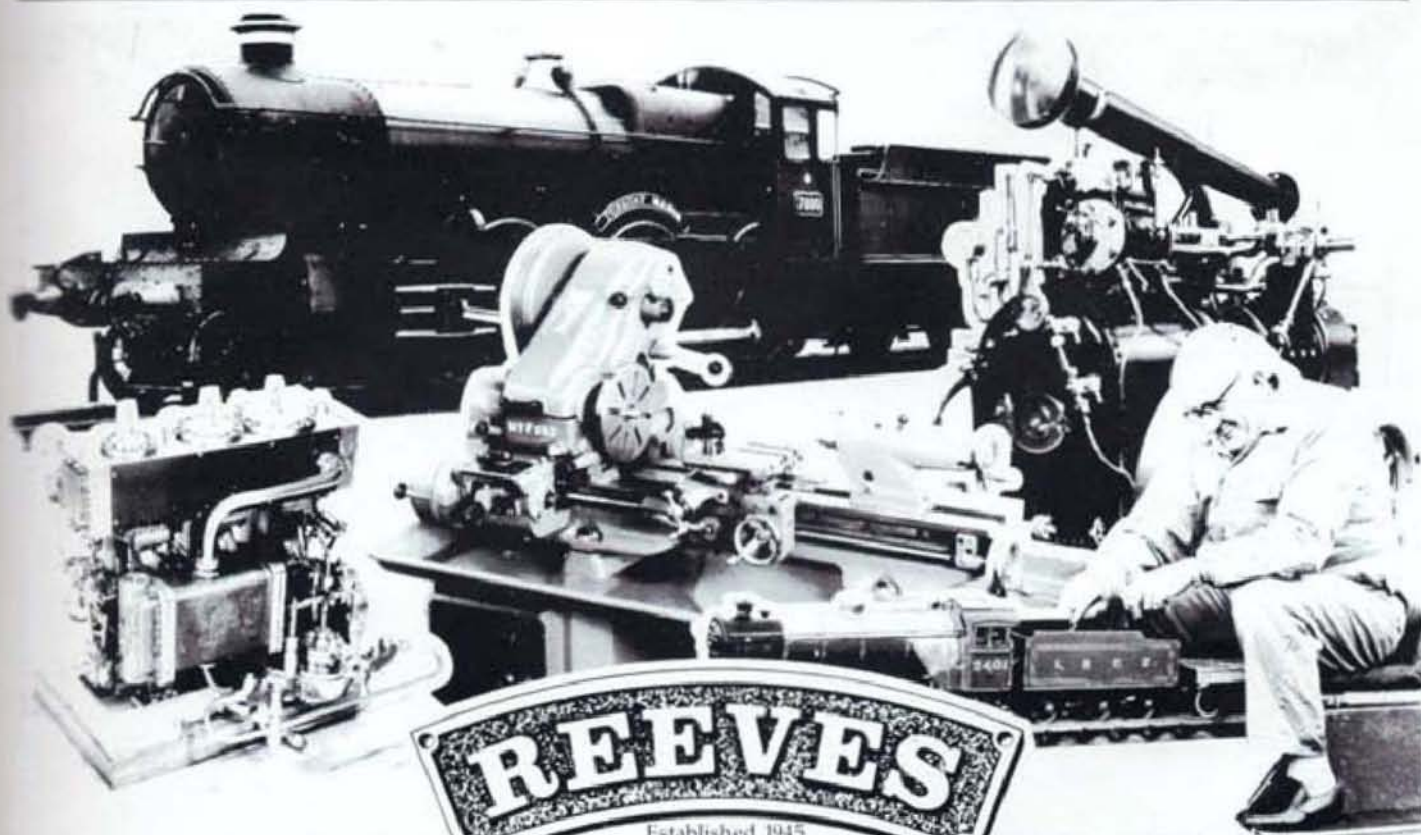
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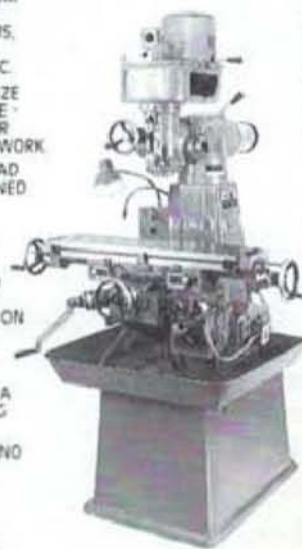


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